PB81-208985

DETERMINANTS OF CANCER AND CARDIOVASCULAR DISEASE MORTALITY IN ASBESTOS MINING COUNTIES OF CALIFORNIA

Science Applications, Inc.
Los Angeles, CA

May 80

U.S. Department of Commerce
National Technical Information Service
NTIS

PB81 208985

SAI-068-81-514

PB81 208985

39

PB81-208985
SAI-068-81-514

DETERMINANTS OF CANCER AND CARDIOVASCULAR DISEASE MORTALITY IN ASBESTOS MINING COUNTIES OF CALIFORNIA

FINAL REPORT

1 MAY 1980

R.A. Ziskind

D.F. Smith
J.L. Hahn
G. Spivey

SUBMITTED TO:

U.S. ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

114

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO. EPA-600/1-81-042	2.	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE Determinants of Cancer and Cardiovascular Disease Mortality in Asbestos Mining Counties of California		5. REPORT DATE 1 May 1980 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) R.A. Ziskind, D.A. Smith, J.L. Hahn, G. Spivey		8. PERFORMING ORGANIZATION REPORT NO. SAI-1-068-81-514
9. PERFORMING ORGANIZATION NAME AND ADDRESS Science Applications, Inc. 1801 Avenue of the Stars, Suite 1205 Los Angeles, California 90067		10. PROGRAM ELEMENT NO. 11. CONTRACT/GRANT NO. 68-02-3258
12. SPONSORING AGENCY NAME AND ADDRESS U.S. Environmental Protection Agency HERL Research Triangle Park, NC 27711		13. TYPE OF REPORT AND PERIOD COVERED Final Report -9/12/79-3/12/80 14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

Technical Contract Managers - G. Wilkinson and John Acquavella, Epidemiology Branch, USEPA

16. ABSTRACT

The purpose of this work was to design an epidemiological study protocol to further evaluate the hypothesis that asbestos related health effects have been observed among populations without occupational exposure. A case-control mortality protocol was developed. The hypothesis was formalized as deaths due to respiratory tract cancer, mesothelioma, and cardiovascular disease are associated with length of residence proximal to asbestos mining activities after controlling for the effects of cigarette smoking, occupation and genetic susceptibility. Study areas selected were the two commercial asbestos mining and milling regions of California. Anthropogenic and natural emission sources of asbestos were delineated. In concert with protocol design a questionnaire for survivors was drafted, pre-tested, revised, and submitted. California death certificate tapes from 1970 will be utilized to define the study subjects and examine mortality in the prime study areas - Calaveras and Tuolumne Counties.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
epidemiology asbestos case-control chrysotile mesothelioma		

18. DISTRIBUTION STATEMENT	19. SECURITY CLASS *(This Report)* Unclassified	21. NO. OF PAGES 103
	20. SECURITY CLASS *(This page)* Unclassified	22. PRICE

EPA Form 2220-1 (Rev. 4-77) PREVIOUS EDITION IS OBSOLETE

NOTICE

THIS DOCUMENT HAS BEEN REPRODUCED FROM THE BEST COPY FURNISHED US BY THE SPONSORING AGENCY. ALTHOUGH IT IS RECOGNIZED THAT CERTAIN PORTIONS ARE ILLEGIBLE, IT IS BEING RELEASED IN THE INTEREST OF MAKING AVAILABLE AS MUCH INFORMATION AS POSSIBLE.

1.a

TABLE OF CONTENTS

PAGE

1.0 INTRODUCTION 1

2.0 EPIDEMIOLOGIC PROTOCOL DESIGN 5

- 2.1 Background and Overview 5
- 2.2 Published Mortality Data 8
- 2.3 State Mortality Tapes 17
- 2.4 Case Selection 20
- 2.5 Control Group Selection 21
- 2.6 Development of Exposure Indices 22
- 2.7 Study Protocol Completion Phase 27
- 2.8 Analysis 29
- 2.9 Cause of Death Distribution With Respect to Ambient Asbestos Concentration - Preliminary Scoping 30
- 2.10 Comments on Statistical Sampling Size 32

3.0 SOURCE INVENTORY AND EXPOSURE ESTIMATION 33

- 3.1 Overview and Conclusions 33
- 3.2 Calaveras and Tuolumne Counties 36
  - 3.2.1 General Area Description and Mining Activities 36
  - 3.2.2 Occupational and Environmental Levels of Airborne Asbestos 46
  - 3.2.3 Background: Asbestos in Water - Calaveras and Tuolumne Counties 54
  - 3.2.4 Occupations Associated with Asbestos Exposure - Calaveras and Tuolumne Counties 65
  - 3.2.5 Potential Environmental Exposure to Asbestos Road Material 66
  - 3.2.6 Relationship Between Asbestos Concentrations in Water and Air 67
- 3.3 Central/Coastal California Asbestos Region 70
  - 3.3.1 General Area Description and Mining Activitiy 70
  - 3.3.2 Occupational and Environmental Levels of Airborne Asbestos 74

TABLE OF CONTENTS

PAGE

3.3.3 Other Environmental Exposure From the New Idria Deposit 75

3.3.4 New Idria Deposit - Exposure Potential Conclusions 78

4.0 QUESTIONNAIRE DEVELOPMENT 79

4.1 Considerations in Designing the Questionnaire 79

4.2 Use of Time Line 80

4.3 Requirement for Completion of the Questionnaire 83

4.4 Information Recorded by the Questionnaire 84

4.4.1 Respondent's Knowledge of the Subject 84

4.4.2 Residence History 85

4.4.3 Potential Confounding Variables 85

4.4.4 Demographic Variables 86

4.5 Asbestos Questionnaire Draft 87

4.6 Interviewer Training 99

4.7 Data Management 99

4.8 Quality Control 100

REFERENCES 102

LIST OF TABLES

PAGE

2.1 Age by Color and Sex: Calaveras County 12

2.2 Age by Color and Sex: Tuolumne County 13

2.3 Calaveras and Tuolumne Population by Subdivision 14

2.4 Deaths From Selected Causes 15

2.5 Deaths by Age for Counties 16

3.1 Calaveras and Tuolumne County Mines 42

3.2 Summary of Safety Inspections for Calaveras Asbestos by California Mining and Tunneling Unit 47

3.3 Recorded Inspections - Copperopolous Asbestos 48

3.4 Emission Factors for Asbestos From Mining and Milling 50

3.5 Measured Dust Concentrations 51

3.6 Chrysotile Asbestos Fibers Near Los Angeles Freeways 68

3.7 Air Samples Collected on 37 mm Filters, Analyzed for Fibers by Light Microscopy, Using OSHA Techniques From the New Idria Serpentine Formation 76

3.8 Comparison of Light and Electron Microscopic Counts of Fibers Collected on Personal Samplers Worn by Motorcyclist No. 4 and by the Ranger 77

LIST OF FIGURES

		PAGE
2.1	County Map of California	6
2.2	Certificate of Death	18
2.3	Western Calaveras and Tuolumne County Area	25
3.1	Serpentine Areas of Calaveras and Tuolumne Counties	34
3.2	Commercial Asbestos Mining/Milling Area of the New Idria Deposit	35
3.3	Asbestos Deposits of California	37
3.4	Serpentine Deposits of Tuolumne County	38
3.5	Serpentine Deposits of Calaveras County	39
3.6	Geologic Map of Calaveras County	40
3.7	Mines and Mineral Deposits Calaveras County	41
3.8	San Andreas Area Map	55
3.9	Geologic Map San Andreas Area	56
3.10	Copperopolis Area Map	57
3.11	Geologic Map Copperopolis Area	58
3.12	Angels Camp Area Map	60
3.13	Geologic Map Angels Camp Area	61
3.14	Valley Springs Area Map	62
3.15	Geologic Map Valley Springs Area	63
3.16	Geologic Map Tuolumne Western County	64
3.17	Index Map to Asbestos Deposits and Mills in the Vicinity of Coalinga, Fresno County	71
3.18	California Areas of Interest to the Program	72
3.19	Geologic Map of the New Idria Mining District, California	73

INDEX TO MAPS

Figure 3.4	Geological Map of California	San Jose Sheet
Figure 3.5	Geological Map of California	Sacramento Sheet
Figure 3.6	Geological Map of California	Calaveras County
Figure 3.7	Map of Calaveras County showing Mines and Mineral Deposits, except Gold	
Figure 3.8	See Figure 3.7	
Figure 3.9	See Figure 3.6	
Figure 3.10	See Figure 3.7	
Figure 3.11	See Figure 3.6	
Figure 3.12	See Figure 3.7	
Figure 3.13	See Figure 3.6	
Figure 3.14	See Figure 3.7	
Figure 3.15	See Figure 3.6	
Figure 3.16	See Figure 3.4	

ACKNOWLEDGEMENTS

We wish to express our gratitude to the program managers Dr. Gregg Wilkinson and Mr. John Acquavella of the U.S. Environmental Protection Agency. We appreciate their active participation and careful technical review in the conduct of this project.

We acknowledge the assistance provided by the following individuals: M. Shields - California Department of Public Health; J. Krancher - Sanitarian Fresno County; J. Bashian, L. Dooley - Fresno County Regional Air Quality Management District; J. Browning, J. Meyers, H. Rhodes - Union Carbide; M. Dell'Orto, R. Hoylman - Calaveras Asbestos Ltd.; J. Hinton - Cal OSHA OCCU; E. Withycombe - Mountain Counties Air Quality Officer; J. Abercromby, J. Hanson - Monterey/San Benito County Air Quality Management District; G. Bunker and his staff - Cal OSHA Mining and Tunneling; G. Woods - U.S. Environmental Protection Agency, Research Triangle Park; H. Leonard - California Air Resources Board; J. Weslowski - California Air Industrial Hygiene Laboratory.

We particularly appreciate the preparation and editing of the typed manuscript by Ms. Rhona Lubaroff.

1.0

INTRODUCTION

The purpose of this work was to design an epidemiological study protocol to further evaluate the hypothesis that asbestos related health effects have been observed among populations without occupational exposure. The hypothesis was formalized as: deaths due to respiratory tract cancer, mesothelioma, and cardiovascular disease are associated with length of residence proximal to asbestos mining activities after controlling for the effects of cigarette smoking, occupation, and genetic susceptibility.

This program was divided into four conceptual tasks:

Epidemiological protocol design. In this segment alternative study approaches were evaluated. The mortality data base, the sources and the exposure to asbestos were considered.

Questionnaire development. In concert with protocol design and exposure findings the primary data gathering mechanism for obtaining subject information from survivors was drafted, pretested, revised and submitted.

Source inventory and exposure characterization. All anthropogenic and natural emission sources of asbestos were delineated and quantified in each California study area. Existing occupational and ambient data were reviewed to establish inhalation and ingestion population exposure.

Quality assurance. Elements of quality assurance were to be identified and documented as part of the protocol design.

The initial component of this study which was undertaken was the source inventory and exposure characterization. A complete discussion of the findings are presented in Section 3. of this report. A summary of the principal findings are given here.

Two distinct California asbestos mining and milling areas were researched. One is associated with a serpentine deposit running through the junction of Fresno and San Benito counties (herein referred to as the New Idria Deposit). The second is located throughout the western sections of Calveras and Tuolumne Counties (the Calaveras Deposit). The preferable study area has been determined to be that associated with the Calaveras Deposit. Selection criteria are threefold - greatest population base, evidence of elevated airborne and waterborne concentrations of asbestos, and the existance of archives of useful ambient air sampler filters dating back over seven years.

For the case of the New Idria Deposit, the mining areas are sufficiently remote to make it unlikely that any population center will be affected. One mill is located near a community and limited airborne asbestos measurements point to significant concentrations there at the time taken.

By contrast the Calaveras Deposit area has a greater at-risk population as a result of mining and milling of asbestos and other minerals. In addition airborne background ambient levels taken upwind or remote from known sources are elevated. No waterborne asbestos measurements have been made specifically for the water distribution systems serving the Calaveras Deposit area. However measurements on San Francisco Bay water district reservoirs located in western Calaveras and Tuolumne counties show higher than average concentrations for those with supplies passing through serpentine formations. The oldest ambient data uncovered for the Calaveras Deposit area was reported in the California Department of Health Study of 1965-1967. Asbestos concentration was measured by dust sample collection through impingers. Quantification was by optical microscopy. Measured ambient levels (upwind at a large mine site, etc.) on two separate occasions ranged between 0.1 and 2 million particles per cubic foot of air. A federal study at about the same time of the area "Environmental Survey of Asbestos Mining and Milling in California" December 1966 Public Health Service Division of Occupational Health suggests the equivalence 10 total fibers/cc ≡ 1mppcf by impinger. In the cited ambient concentrations (from the NIOSH Recommended Asbestos Standards) the levels across the country are summarized as generally < 10 ng/m^3 with occasional peaks as high as 100 ng/m^3 (by electron microscopy). Using optical microscopy ambient levels are generally less than 0.01 fibers > 5 μm/cc with peak values as high as 0.03 fibers > 5 μm/cc. Using the Public Health Service equivalence 6 fibers > 5 μ/cc ≡ 1 mppcf by impinger yields the mine area ambient (upwind) concentration range 0.6 - 12 fibers/cc.[*] Further using the NIOSH suggested equivalent 20 fibers > 5 μm in length (as determined by optical microscopy) per nanogram of asbestos yields the mine ambient range 12 -240 ng/m^3. Thus the ambient levels detected at upwind locations in the vicinity of a Calaveras mine/mill are at the extreme high end of the surveyed range.

---

[*] Note the current NIOSH recommended standard is 0.1 fiber/cc for an 8-hour time-weighted average.

High volume air sampler filters from the Calaveras Deposit area population centers have been located in the California Air Resources Board archives dating back to the early 1970s. These can be utilized to quantify airborne asbestos concentration and therefore approximate exposure data. These coupled with the water assay will establish the quantitative relationship among population centers in the serpentine area and the other areas of Calaveras and Tuolumne counties. These will provide the basis for stratifying the populations according to inhalation and ingestion exposure.

Based upon the source and exposure information available to this study the potential study group was defined as those individuals who died in Calaveras and Tuolumne Counties during the last ten years. Approximately 4,300 individuals would be expected to be included. Exposure of the preliminarily identified group is expected to be significant and principally due to general ambient sources rather than a dominant single point source. Exposure may be differentiated among the group members between air and water with the former or latter predominating in particular residential segments. This will allow investigation of the relative importance of different exposure routes and facilitate interpretation of possible dose-effect relationships. Water distribution systems for the area back through the last ten years have been described.

Recommendation

It is proposed that water sampling and air/water analysis be conducted to define the exposure among the population by place of residence. In parallel with this effort information from the California death tape rolls can be initially extracted on an annual basis for the two counties. These tapes can be processed according to cause of death (ICD system) with case and control groups extracted and disease mortality rates compiled. The potential sample size of all cause of death categories of interest would be examined. All diseases associated with occupational exposure to asbestos would be considered as cases. In additional all death categories of sufficient size can be contrasted as a function of exposure. The product of this effort is the delineation of the range of correlation of mortality categories with exposure, This may suggest additional cause of death categories which may be usefully examined. These steps will be followed by the final study components which will include the detailed data gathering by survivor questionnaire and medical records and the comprehensive data analyses.

2.0
EPIDEMIOLOGIC PROTOCOL DESIGN

2.1 BACKGROUND AND OVERVIEW

An objective of this study was to develop an epidemiologic protocol to investigate the mortality patterns of the general population in asbestos mining areas of California. In Section 3.0 the results are presented of an inventory of asbestos sources and population exposure. In that study segment it was determined that there was sufficient information available to conclude that elevated asbestos exposure to the general population of two areas probably had occurred.

In one area (Calaveras and Tuolumne Counties) residents of a number of communities are postulated to have been exposed for many years to combinations of elevated airborne and waterborne concentrations due to the migration of naturally occurring asbestos bearing materials. In addition mining and quarry activities throughout this century are thought to be important sources. The population of the areas of these counties located in or near serpentine formations represents approximately one half of the greater-than 35,000 two county residents. Scaling the annual death rate accordingly yields approximately two hundred and twenty-five deaths in the serpentine areas.

The second area is comprised of the communities of King City and San Lucas in Monterey County. These towns are closest to an asbestos mill just south of King City. It has been decided to concentrate attention upon the Calaveras/Tuolumne County area for the current time since the population base is greater and the period of exposure has been longer. Discussion of these factors is contained in Section 3.

Figure 2.1 illustrates the counties in California. Figure 3.3 overlays the asbestos deposits. The areas of most interest are associated with the commercial grade serpentine bodies in western Calaveras and Tuolumne Counties labeled C and M1 in Figure 3.3.

The epidemiologic protocol has been developed with the following elements in mind.

1. Identification of cases and controls

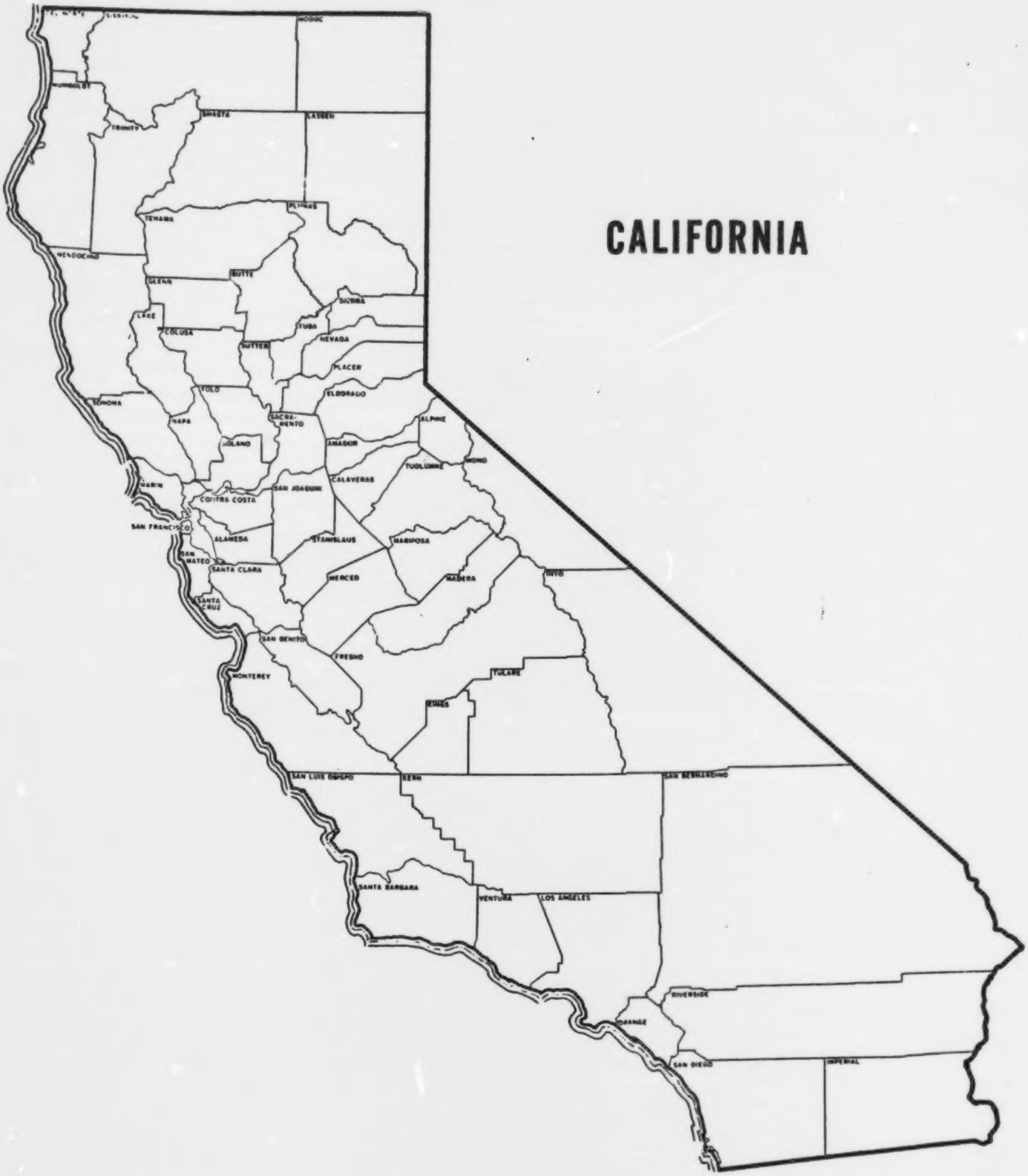

CALIFORNIA
MODOC
HUMBOLDT
SHASTA
LASSEN
TRINITY
TEHAMA
PLUMAS
MENDOCINO
GLENN
BUTTE
SIERRA
LAKE
COLUSA
YUBA
NEVADA
SUTTER
PLACER
YOLO
ELDORADO
SONOMA
NAPA
SACRA-
MENTO
ALPINE
SOLANO
AMADOR
MONO
TUOLUMNE
MARIN
CONTRA COSTA
SAN JOAQUIN
CALAVERAS
SAN FRANCISCO
ALAMEDA
STANISLAUS
MARIPOSA
SAN
MATEO
SANTA CLARA
MERCED
MADERA
INYO
SANTA
CRUZ
SAN BENITO
FRESNO
MONTEREY
TULARE
KINGS
SAN LUIS OBISPO
KERN
SAN BERNARDINO
SANTA BARBARA
VENTURA
LOS ANGELES
RIVERSIDE
ORANGE
SAN DIEGO
IMPERIAL

Figure 2.1. County Map of California

2. Procedures for data collection, processing and transmission to EPA
3. Method for pretesting of the questionnaire
4. Documentation and training for study staff
5. Quality control procedures including data processing
6. Assignment of personal exposure index.

These elements embody Statement of Work items #2, 3, 4, and 5. Item 6 - budgetary estimates necessary to perform the full study were treated separately.

History

This research program evolved from an EPA in-house pilot study comparing the relationship of mortality indicators in U.S. asbestos mining counties with non-mining counties. That pilot study examined cancer, respiratory disease and cardiovascular disease mortality for the years 1969-1971. Comparison of the death rate of groups were broken down by sex, population density and also into white and non-white populations. Elevated relative risk ratios were suggestive for several mortality categories. It was at this point that this study was initiated. The plan was to start by examining the sources responsible for asbestos exposure amongst several areas and delineate suitable study and control populations.

2.2 PUBLISHED MORTALITY DATA

It was not possible to obtain and manipulate death certificate tapes from the counties of interest during this study phase. However gross published mortality data and other published statistics were examined (California, 1976 and 1973) in order to evaluate the subsequent study protocol alternatives. Some of these data are summarized below.

Selected Populations 1970, 1972-1976

Census Population

	4/1/70	7/1/72	7/1/73	7/1/74	7/1/76	7/1/76
California	19,953,134	20,437,000	20,665,000	20,907,000	21,198,000	21,522,000
Calaveras County	13,585	14,300	14,700	15,300	15,500	16,000
Tuolumne County	22,169	23,700	24,600	25,200	26,600	27,500

Live births in Calaveras County during 1976 numbered 157 with 150 classified as Caucasian. Corresponding numbers for Tuolumne were 299 and 288. In 1976 total deaths were:

	Total	Male	Female
California	171,095	93,191	77,904
Calaveras	163	105	58
Tuolumne	270	163	107

The ten principal causes of death in California in 1976 and the corresponding numbers and rates for the two counties were:

	Cause of Death	Eighth Revision International List Number	California			Calaveras			Tuolumne		
			Number	Rate	%	Number	Rate	%	Number	Rate	%
	All Causes		171,095	795	100	163	1019	100	270	982	100
1.	Diseases of the Heart	390-398, 402, 404, 410-414, 420-429	61,201	284	35.8	65	406	39.9	97	353	35.9
2.	Malignant Neoplasms	140-209	36,048	167	21.1	30	187	18.4	63	229	23.3
3.	Cerebrovascular Diseases	430-438	17,590	82	10.3	9	56	5.5	25	91	9.2
4.	Accidents	800-949	10,125	47	5.9	12	75	7.4	25	91	9.2
5.	Influenza & Pneumonia	470-474, 480-486	4,951	23	2.9	2	12	1.2	12	44	4.4
6.	Cirrhosis of the Liver	571	4,342	20	2.5	1	6	.6	2	7	.7
7.	Suicide	950-959	3,791	18	2.2	3	19	1.8	9	33	3.3
8.	Repiratory Diseases Designated Obstruction	490-493 517-518	2,994	14	1.7	5	31	3.0	5	18	1.8
9.	Arteriosclerosis	440	2,609	12	1.5	2	12	1.2	3	11	1.1
10.	Diabetes Mellitus	250	2,340	11	1.4	0	0	0	5	18	1.8
11.	All Other Causes		25,104	117	14.7	34	212	21.	24	87	9.3

Rates are specified per 100,000 population.

Special comments are in order related to this table. The numbers are crude rates only and are not adjusted for sex, age, or race. Quantities are given for 1976. It is expected that the ten year period 1970-1979 will be utilized to provide the data source for this study. Therefore absolute numbers will be close to nine or ten times those shown above, i.e., 10 (163 + 270) ≃ 4300. This will allow a sufficient data base to use subcategories of the more significant causes of death such as 402, 404 (hypertensive heart disease with and without renal disease) versus 410-414 (ischemic heart disease).

We are particularly interested in subdividing the grouping of heart diseases since preliminary EPA findings suggest that hypertensive heart disease may be associated with asbestos exposure while arteriosclerotic heart disease is not.

Each of approximately 100 published causes of death subcategories were tabulated from the sex specific 1976 data for the two counties and the crude rates compared with crude statewide rates. In some cases individual subcategory rates were over three times state rates. No attempt was made to present this material or to utilize these results in study design because the statistical basis was inadequate.

Deaths from selected respiratory diseases were tabulated and summarized in the 1976 California mortality literature. Included among these were respiratory cancer sites of the trachea, bronchus, lung, and pleura (162, 163.0). Based on these data approximately 200 lung cancer deaths can be expected during the ten year interval.

	California	Calaveras	Tuolumne
Total	8,452	10	16
Rate per 100,000 population	39.3	62.5	58.2

Very little additional county level information is provided in the published presentations of mortality. There are selected age distribution breakdowns for respiratory disease categories and absolute numbers of deaths versus various groupings of cause. However breakdown and analysis by sex, age, etc. must await receipt of tapes.

Census information from 1960 and 1970 was utilized in this study and is presented below. Table 2.3 provides a coarse breakdown of the distribution of population within each county. Population centers are tabulated in the Rand McNally Atlas and support the estimate that approximately 50 percent of county deaths would be expected to occur in communities in proximity to serpentine deposits. Until additional information is analyzed no closer estimate can be made. Thus the preliminary conclusion is that there will be an adequate differentiation among the population with respect to the asbestos exposure indices.

Table 2.1

AGE BY COLOR AND SEX: CALAVERAS COUNTY

	1960 POPULATION							1970 POPULATION						
	ALL CLASSES			WHITE		NONWHITE		ALL RACES			WHITE		NEGRO	
	TOTAL	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	TOTAL	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE
5	882	466	416	453	404	13	12	804	400	404	389	387	--	1
5-9	893	468	425	464	418	4	7	1045	522	523	509	510	1	--
10-14	1070	627	443	569	437	58	6	1299	734	565	661	543	53	1
15-19	636	329	307	325	301	4	6	1106	631	475	593	467	24	--
20-24	461	222	239	219	228	3	11	670	339	331	322	326	9	--
25-29	489	234	255	226	251	8	4	702	359	343	347	343	7	--
30-34	538	376	262	271	259	5	3	689	368	321	310	311	4	--
35-39	620	314	306	308	299	6	7	689	336	353	323	344	1	--
40-44	596	296	300	288	397	8	3	788	405	383	381	367	8	--
45-49	700	356	344	349	338	7	6	837	423	414	417	412	4	--
50-54	680	364	316	357	316	7	--	859	411	448	395	442	7	1
55-59	662	359	303	351	297	8	6	916	459	457	447	454	2	1
60-64	563	314	249	303	241	11	--	959	454	505	447	502	1	--
65-69	545	310	235	304	234	6	1	791	442	349	436	344	4	--
70-74	417	239	178	231	177	8	1	532	298	234	293	233	2	--
75-79	287	161	126	158	125	3	1	361	192	169	189	168	1	--
80-84	153	93	60	90	60	3	--	188	86	102	83	101	--	--
85+	97	55	42	51	41	4	1	350	245	105	60	86	6	--

Census of the Population
Characteristics of the Population
California, 1960, 1, pt. 6. & 1970.

Table 2.2

AGE BY COLOR AND SEX: TUOLUMNE COUNTY

	1960 POPULATION							1970 POPULATION						
	ALL CLASSES			WHITE		NONWHITE		ALL RACES			WHITE		NEGRO	
	TOTAL	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	TOTAL	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE
5	1264	661	583	669	582	12	1	1437	744	693	725	673	2	--
5-9	1268	669	599	660	591	9	8	1797	961	836	931	825	1	1
10-14	1339	699	640	686	630	13	10	2052	1124	928	1104	909	5	3
15-19	940	486	454	480	447	6	7	1821	942	879	920	864	4	3
20-24	622	304	318	301	316	3	2	1378	831	547	689	528	54	--
25-29	729	363	366	311	226	52	30	1426	834	592	688	572	48	--
30-34	844	428	416	417	412	11	4	1371	783	588	668	574	45	1
35-39	1002	502	500	497	497	5	3	1245	700	545	617	534	48	3
40-44	949	466	483	461	477	5	6	1395	711	684	647	672	23	1
45-49	1046	545	501	532	497	13	4	1497	779	718	737	706	9	1
50-54	988	522	466	515	460	7	6	1364	682	682	669	670	--	1
55-59	850	470	389	464	376	6	4	1370	675	695	663	688	--	--
60-64	751	393	358	389	355	4	3	1258	623	635	615	631	2	--
65-69	714	378	336	369	336	9	1	1068	586	482	579	476	--	--
70-74	481	256	225	253	223	3	2	778	377	401	370	399	1	1
75-79	313	164	149	163	147	1	3	470	339	241	224	241	--	--
80-84	185	87	98	86	98	1	--	252	110	142	108	142	--	--
85+	119	52	67	52	66	--	1	190	65	125	64	125	--	--

Table 2.3

CALAVERAS AND TUOLUMNE POPULATION BY SUBDIVISION

COUNTY SUBDIVISON	1970	1960	PERCENT CHANGE
Calaveras County	13,585	10,289	32.0
Angels Division	4,520	3,820	18.3
Angels City	1,710	1,121	52.5
San Andreas Division	5,064	4,391	15.3
San Andreas (U)	1,564	1,416	10.5
West Point-Wilseyville Division	4,001	2.078	92.5
Tuolumne County	22,169	14,404	53.9
Groveland Division	884	885	3.4
Sonora Division	12,498	7,913	57.9
Sonora City	3,100	2,725	13.8
Stanislaus-Yosemite Division	786	726	8.3
Twain Harte-Tuolumne Division	8,001	4,910	63.0
Tuolumne (U)	1,365	1,403	-2.7
Twain Harte (U)	1,484	---	---

Table 2.4
DEATHS FROM SELECTED CAUSES

	CALAVERAS	TUOLUMNE
1961		
- Malignant neoplasms of the trachea, bronchus and lung	6	2
- Other respiratory cancer	--	1
- Cardiovascular-Renal Disease	68	97
- Diseases of the heart	40	70
1970		
- Malignant neoplasms of the trachea, bronchus and lung	7	8
- Other respiratory cancer	--	--
- Diseases of the circulatory system	90	123
- Diseases of the heart	66	84
1976		
- Malignant neoplasms of the trachea, bronchus and lung	10	16
- Other respiratory cancer	--	--
- Diseases of the circulatory system	79	133
- Diseases of the heart	65	97

Vital Statistics of California 1961, 1970, 1976

Table 2.5

DEATHS BY AGE FOR COUNTIES
(by place of residence)

	TOTAL	<1	1-4	.5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	UNK
Calaveras																					
1961	129	5	1	-	1	--	2	1	-	2	4	3	5	13	8	16	20	20	14	14	--
1970	161	3	1	1	-	3	4	2	1	-	1	4	6	9	18	26	20	15	21	26	--
1976	163	1	-	1	1	2	3	1	1	3	1	6	7	8	26	19	26	26	16	15	--
Tuolumne																					
1961	179	7	3	--	--	2	1	1	2	4	1	7	10	14	16	23	17	23	21	27	--
1970	219	3	1	1	--	2	2	3	2	2	1	6	11	18	13	26	29	33	30	36	--
1976	270	2	-	1	1	2	6	6	5	1	6	7	19	18	28	43	35	26	31	32	--

Vital Statistics of California
State of California Health and Welfare Agency
Department of Health Services, 1961, 1970, 1976.

2.3 STATE MORTALITY TAPES

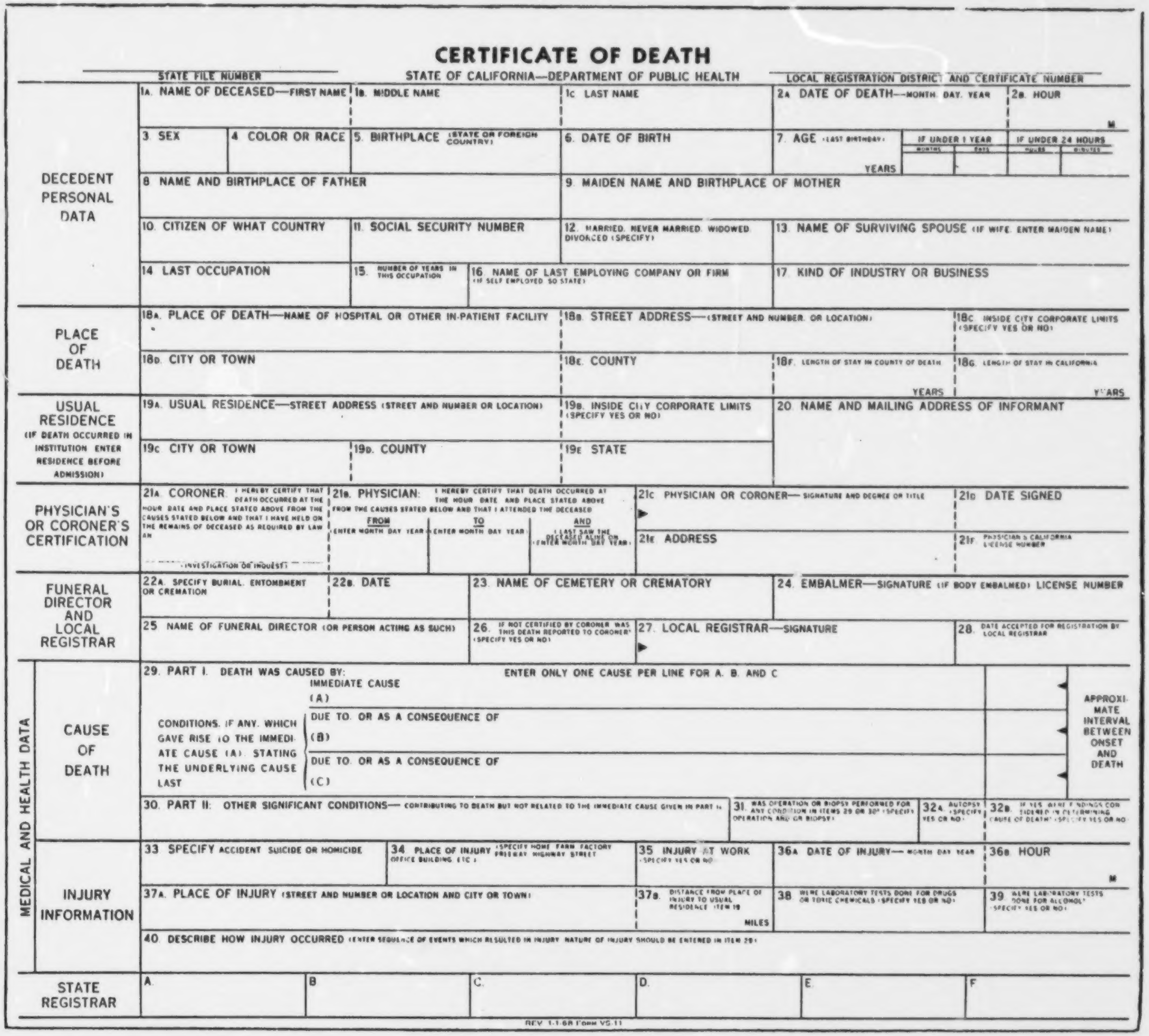
Both cases and controls will be identified from the California state death tapes. The tapes are compiled monthly alphabetically by county and within each county listing. Thus we have:

January County A
Subject A - death certificate information
Subject B - death certificate information
.
.
.
County B
Subject A'
.
.
.
County Z
.
.
.
February County A

We will obtain tapes for Calaveras and Tuolumne Counties over the last ten years (1970-1979) and sort into groups according to the International Classification of Diseases code for the underlying cause of death. These tapes have coded the basic information from the death certificate including the full name, date of death, sex, race, birthplace, date of birth, age, county of death and residence, cause of death code (4 digit), local (county) file number. Figure 2.2 illustrates the full reproduction of a death certificate. The local file number or state file number will be utilized as an identification index.

A maximum of ten years will be selected in order to gain a sufficient statistical base while not proceeding into the more distant past thereby complicating the study by introducing earlier revisions (than the eighth and ninth revisions of the ICDA codes) of the cause of death code and most importantly increasing difficulties in locating useful (informed survivors).

Figure 2.2
CERTIFICATE OF DEATH



CERTIFICATE OF DEATH

STATE FILE NUMBER

STATE OF CALIFORNIA—DEPARTMENT OF PUBLIC HEALTH

LOCAL REGISTRATION DISTRICT AND CERTIFICATE NUMBER

DECEDENT PERSONAL DATA

1A. NAME OF DECEASED—FIRST NAME
1B. MIDDLE NAME
1C. LAST NAME
2A. DATE OF DEATH—MONTH, DAY, YEAR
2B. HOUR M
3. SEX
4. COLOR OR RACE
5. BIRTHPLACE (STATE OR FOREIGN COUNTRY)
6. DATE OF BIRTH
7. AGE (LAST BIRTHDAY) YEARS
IF UNDER 1 YEAR: MONTHS, DAYS
IF UNDER 24 HOURS: HOURS, MINUTES
8. NAME AND BIRTHPLACE OF FATHER
9. MAIDEN NAME AND BIRTHPLACE OF MOTHER
10. CITIZEN OF WHAT COUNTRY
11. SOCIAL SECURITY NUMBER
12. MARRIED, NEVER MARRIED, WIDOWED, DIVORCED (SPECIFY)
13. NAME OF SURVIVING SPOUSE (IF WIFE, ENTER MAIDEN NAME)
14. LAST OCCUPATION
15. NUMBER OF YEARS IN THIS OCCUPATION
16. NAME OF LAST EMPLOYING COMPANY OR FIRM (IF SELF EMPLOYED, SO STATE)
17. KIND OF INDUSTRY OR BUSINESS

PLACE OF DEATH

18A. PLACE OF DEATH—NAME OF HOSPITAL OR OTHER IN-PATIENT FACILITY
18B. STREET ADDRESS—(STREET AND NUMBER, OR LOCATION)
18C. INSIDE CITY CORPORATE LIMITS (SPECIFY YES OR NO)
18D. CITY OR TOWN
18E. COUNTY
18F. LENGTH OF STAY IN COUNTY OF DEATH YEARS
18G. LENGTH OF STAY IN CALIFORNIA YEARS

USUAL RESIDENCE (IF DEATH OCCURRED IN INSTITUTION, ENTER RESIDENCE BEFORE ADMISSION)

19A. USUAL RESIDENCE—STREET ADDRESS (STREET AND NUMBER OR LOCATION)
19B. INSIDE CITY CORPORATE LIMITS (SPECIFY YES OR NO)
19C. CITY OR TOWN
19D. COUNTY
19E. STATE
20. NAME AND MAILING ADDRESS OF INFORMANT

PHYSICIAN'S OR CORONER'S CERTIFICATION

21A. CORONER: I HEREBY CERTIFY THAT DEATH OCCURRED AT THE HOUR, DATE AND PLACE STATED ABOVE FROM THE CAUSES STATED BELOW AND THAT I HAVE HELD ON THE REMAINS OF DECEASED AS REQUIRED BY LAW AN (INVESTIGATION OR INQUEST)
21B. PHYSICIAN: I HEREBY CERTIFY THAT DEATH OCCURRED AT THE HOUR, DATE AND PLACE STATED ABOVE FROM THE CAUSES STATED BELOW AND THAT I ATTENDED THE DECEASED FROM (ENTER MONTH, DAY, YEAR) TO (ENTER MONTH, DAY, YEAR) AND I LAST SAW THE DECEASED ALIVE ON (ENTER MONTH, DAY, YEAR)
21C. PHYSICIAN OR CORONER—SIGNATURE AND DEGREE OR TITLE ▶
21D. DATE SIGNED
21E. ADDRESS
21F. PHYSICIAN'S CALIFORNIA LICENSE NUMBER

FUNERAL DIRECTOR AND LOCAL REGISTRAR

22A. SPECIFY BURIAL, ENTOMBMENT OR CREMATION
22B. DATE
23. NAME OF CEMETERY OR CREMATORY
24. EMBALMER—SIGNATURE (IF BODY EMBALMED) LICENSE NUMBER
25. NAME OF FUNERAL DIRECTOR (OR PERSON ACTING AS SUCH)
26. IF NOT CERTIFIED BY CORONER, WAS THIS DEATH REPORTED TO CORONER? (SPECIFY YES OR NO)
27. LOCAL REGISTRAR—SIGNATURE ▶
28. DATE ACCEPTED FOR REGISTRATION BY LOCAL REGISTRAR

MEDICAL AND HEALTH DATA

CAUSE OF DEATH

29. PART I. DEATH WAS CAUSED BY: ENTER ONLY ONE CAUSE PER LINE FOR A, B, AND C
IMMEDIATE CAUSE (A)
CONDITIONS, IF ANY, WHICH GAVE RISE TO THE IMMEDIATE CAUSE (A), STATING THE UNDERLYING CAUSE LAST
DUE TO, OR AS A CONSEQUENCE OF (B)
DUE TO, OR AS A CONSEQUENCE OF (C)
APPROXIMATE INTERVAL BETWEEN ONSET AND DEATH
30. PART II: OTHER SIGNIFICANT CONDITIONS—CONTRIBUTING TO DEATH BUT NOT RELATED TO THE IMMEDIATE CAUSE GIVEN IN PART I
31. WAS OPERATION OR BIOPSY PERFORMED FOR ANY CONDITION IN ITEMS 29 OR 30? (SPECIFY OPERATION AND/OR BIOPSY)
32A. AUTOPSY (SPECIFY YES OR NO)
32B. IF YES, WERE FINDINGS CONSIDERED IN DETERMINING CAUSE OF DEATH? (SPECIFY YES OR NO)

INJURY INFORMATION

33. SPECIFY ACCIDENT, SUICIDE OR HOMICIDE
34. PLACE OF INJURY (SPECIFY HOME, FARM, FACTORY, FREEWAY, HIGHWAY, STREET, OFFICE BUILDING, ETC.)
35. INJURY AT WORK (SPECIFY YES OR NO)
36A. DATE OF INJURY—MONTH, DAY, YEAR
36B. HOUR M
37A. PLACE OF INJURY (STREET AND NUMBER OR LOCATION AND CITY OR TOWN)
37B. DISTANCE FROM PLACE OF INJURY TO USUAL RESIDENCE (ITEM 19) MILES
38. WERE LABORATORY TESTS DONE FOR DRUGS OR TOXIC CHEMICALS? (SPECIFY YES OR NO)
39. WERE LABORATORY TESTS DONE FOR ALCOHOL? (SPECIFY YES OR NO)
40. DESCRIBE HOW INJURY OCCURRED (ENTER SEQUENCE OF EVENTS WHICH RESULTED IN INJURY. NATURE OF INJURY SHOULD BE ENTERED IN ITEM 29)

STATE REGISTRAR

A.	B	C.	D.	E.	F

REV. 1-1-68 Form VS-11

The procedure to be followed initially is to tabulate and print out the cause of death categories on an annual basis in order to quantify them and eliminate the causes where insufficient numbers exist. Since the percentage of non-whites in the two counties is small, all deaths of non-whites will be eliminated from the pool. Sex specific and age adjusted mortality rates for each sub-category will be compared for Calaveras County, Tuolumne County and the entire state of California. Additionally SMRs will be calculated and tabulated on an annual, five and ten year aggregate basis. These rates will provide useful ancillary data for later interpretation of study findings. It is also possible to determine proportional mortality ratios as described by Kupper et al., (Kupper, J., Chron. Diseases, V31, Pg 15, 1978) and develop approximate SMRs.

2.4 CASE SELECTION

Causes of death clearly associated with asbestos from previous occupational studies will be included in this study. Thus lung cancer and mesothelioma deaths will be selected as cases. In addition, because of the prior EPA findings, hypertensive heart disease will be used as an additional case group. Other potential (hypothesized) causes of death which could be selected depending on EPA interest are gastrointestinal tract cancer, chronic respiratory disease, and perhaps acute respiratory diseases. The goal will be to have about 200 cases in each cause of death category. Causes of death (except mesothelioma) with fewer than 100 deaths in the two counties for the ten year period will be eliminated from further consideration. Mesothelioma cases wil be investigated regardless of numbers because of their well known relationship with asbestos.

Where more than 200 deaths have occurred during the study period for a given cause of death, the deaths will be sampled for case selection. Since we see no reason to suspect a systematic time-related bias in the deaths the most practical approach to sampling would be to select the most recent 200 deaths. This approach is not only the easiest mechanically but would make the survivor tracing and interviewing easier as well.

2.5 CONTROL GROUP SELECTION

Controls will be chosen randomly from a pool of selected causes of death to match cases on age (± 2½ yrs), sex, and year of death. The pool cannot be specified in detail until the mortality tapes are obtained and analyzed. Major causes of death which on a priori grounds are likely to be unrelated to asbestos exposure will be utilized. Deaths from accidental causes are expected to be included although specific subcategories will be excluded if they are recreationally related and centered in the national park area. Other possibilities would be selected other cancers and non-hypertensive heart disease. Smaller categories may also be included to both increase the size of the pool and reduce the chances of bias which might be associated with a single cause.

The selection procedure will be to randomize the list of selected deaths within each year of death. For each case, the potential control will be the first individual on the list in the year of death who matches on age and sex. As potential controls are selected, they will be crossed off the list to avoid double selection. For a control who's survivor cannot be traced or interviewed, the control will be replaced by the next then available potential control on the list, again matching on age and sex.

2.6 DEVELOPMENT OF EXPOSURE INDICES

Discussion of airborne sources and concentrations of asbestos is presented in Section 3.0. Similarly the sparse water data is covered. It was concluded that obtaining additional ambient concentration data would greatly enhance the epidemiologic study. In the absence of augmented data relatively unsupported assumptions would have to be made to assign differential exposure values to the study population. The ultimate goal of this portion of the study is to define exposure probabilities on the basis of place of residence of study subjects in a form which will allow definition of exposure gradients.

Based upon the following information - airborne and waterborne measurements, area geology, direct observations, occupational literature, and water distribution system descriptions - it was concluded that:

- The ambient exposure to asbestos in population centers in the western regions of Calaveras and Tuolumne Counties are likely to have historically been elevated with respect to the remainder of these counties.
- Historically the primary sources of airborne and waterborne exposure throughout the twentieth century may be that due to natural background and mining/milling activities in serpentine bodies. The human mining activity is known to have occured throughout the western region and is not identified with a single critical source until perhaps twenty years ago. The Calaveras Asbestos operation seven miles southeast of Copperopolis and the adjacent New Melones dam construction activity may have elevated exposure to the proximal area - Jamestown, Sonora, Copperopolis, Columbia, Angel's Camp and several other communities. However upwind and more distant (San Andreas) measurements of airborne asbestos confirm ambient concentrations at the upper end of urban data and in fact probably exceeding current occupational levels.
- The water distribution systems which serve the area have remained virtually unchanged with respect to configuration, materials and controls (which may affect asbestos levels). These are discussed in Section 3. It is expected that systems may differ markedly in asbestos content. Concentrations should be quantified through relatively few asbestos measurements.
- It is important to quantify asbestos concentration as far back into the past as is possible. High volume air samples were taken in several locations in the western county regions. Samples were also taken in other areas and thus could be utilized to confirm background levels.

The calculation of exposure indices shall be determined by the following:

- The published air and water asbestos content data
- The proximity of residence to serpentine deposits
- The results of asbestos analyses of 24 air samples taken over the years 1972-1977.
- The results of asbestos analyses of 24 water samples to be taken.

In order to maximize coverage of the population in these areas (within reasonable budget constraints) and obtain the greatest overlap of air and water sampling data the following water samples are recommended:

1. San Andreas - 2 samples (including replication) taken downstream from the Jefferson Davis Reservoir treatment plant and immediately prior to a principal distribution point for the community.
2. Copperopolis - 2 samples at the Penny Creek Dam site release point.
3. Angels Camp and area supply - 4 samples taken from the Utica and Kiefer Reservoirs.
4. Valley Springs local spring - 2 samples along outflow distribution point.
5. Stockton area - 2 samples taken at the reservoir location and at the tap in Stockton.
6. Tuolumne County - 6 samples taken after treatment at suitable locations along the source to Columbia, Sonora, and Jamestown.
7. Miscellaneous sources - 6 samples taken and analyzed as necessary to characterize exposure of the study populations.

The air samples shall be analyzed from amongst the 24/48 hour collection time high volume particulate collection filters available in the California Air Resources Board archives. Twenty-four sample analyses shall be conducted to provide cost-effective information characterizing the study area in Calaveras and Tuolumne Counties. Sample locations to be considered shall include but not be limited to the following sites - Mariposa, Columbia, Tuolumne City, and Sonora (2 sites). Samples were taken during the period 1972-1977. Other sites are available and final selection awaits inspection and verification of the actual filter condition. The filters typically have one-quarter of their surface area removed with the remainder archived.

The sites in Columbia, Tuolumne City[*], and Sonora (2) should provide the basis for defining the exposure in much of the western areas of the two counties. Previously asbestos analyses were made in San Andreas and upwind and downwind from the New Melones area mine/mill and dam site (approximately midway between Copperopolis and Jamestown on Figure 2.3).

The air and water samples shall be collected, prepared and analyzed by applicable standard EPA procedures:

EPA-600/4-78-011	Preparation of Water Samples for Asbestos Filter Counting by Electron Microscopy
EPA-600/2-77-178	Electron Microscope Measurements of Airborne Asbestos Concentrations

Airborne filters will be prepared for analyses by extraction and placed into a form consistent with final analysis preparation as discussed in EPA-600/4-78-011. The California Air Industrial Hygiene Laboratory (Weslowski, John and others) are interested in participating in this program.

Quality assurance and control procedure requirements specified in the cited documents will be followed and documented accordingly. In addition the applicable sections of the EPA Quality Assurance Handbooks for air pollution measurement systems will be followed as delineated principally in:

EPA-600/9-76-005, January 1976, Volume I - Principles
EPA-600/4-77-027a, May 1977, Volume II - Ambient Air Specific Methods

and their various revisions and supplements.

Results of air and waterborne analyses will provide asbestos levels expressible as number of fibers/m^3 and fibers/liter respectively. These concentrations with the existing data will provide a sufficient basis to assign two indices[+] for each population center. Because of insufficient concentratation data,

---

[*] Note Tuolumne City is located between Twain Harte and Groveland.

[+] Air and water exposure level.

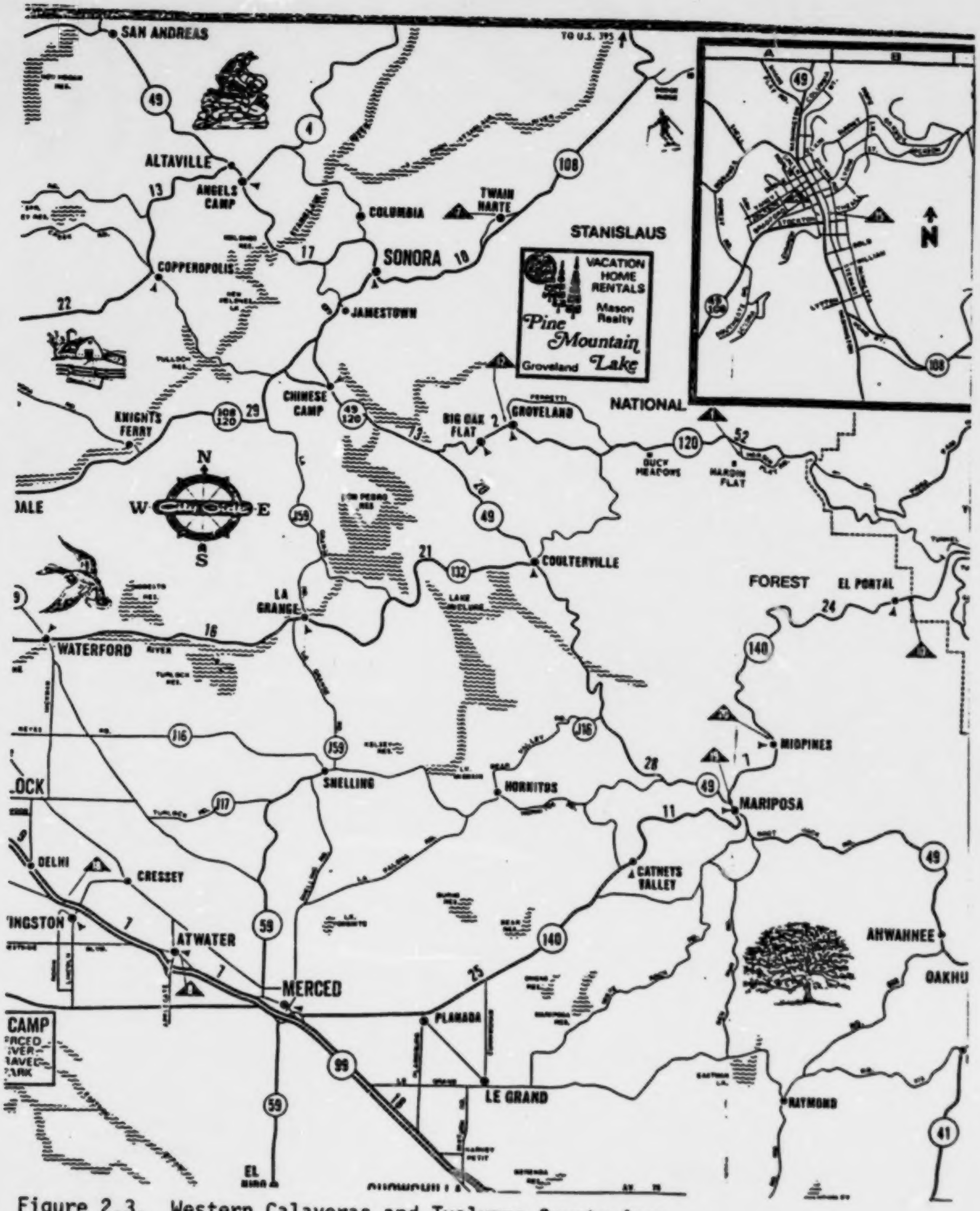

SAN ANDREAS
TO U.S. 395
49
4
ALTAVILLE
ANGELS CAMP
13
COLUMBIA
TWAIN HARTE
108
STANISLAUS
SONORA
17
108
COPPEROPOLIS
JAMESTOWN
22
VACATION HOME RENTALS
Mason Realty
Pine Mountain Lake
Groveland
CHINESE CAMP
KNIGHTS FERRY
108 120
29
49 120
BIG OAK FLAT
GROVELAND
NATIONAL
120
52
BUCK MEADOWS
HARDIN FLAT
N
W
E
S
DALE
J59
49
21
132
COULTERVILLE
FOREST
EL PORTAL
LA GRANGE
WATERFORD
16
140
24
J16
MIDPINES
J59
SNELLING
HORNITOS
28
49
MARIPOSA
LOCK
J17
11
DELHI
CRESSET
CATHEYS VALLEY
49
AHWAHNEE
OAKHU
INGSTON
ATWATER
7
59
MERCED
140
25
PLANADA
99
CAMP
LE GRAND
RAYMOND
41
59
EL NIDO

Figure 2.3. Western Calaveras and Tuolumne County Area.

no attempt will be made to assign a time dependence to these concentration indices. However, length of residence in a given area as determined by questionnaire can be used to devise a time/concentration estimate for each individual. It may also be useful to classify each population center simply as either low or high exposure in water and air. This classification would provide a second analytic technique.

2.7 STUDY PROTOCOL COMPLETION PHASE

After cases and controls have been selected, as described, it will be necessary to gather additional data on times and places of residence to allow characterization of both length and level of exposure, and data on possible confounding factors, for each study subject. This is to be done by means of a questionnaire survey of the survivors of individuals identified as cases or controls (see Section 4.4.2).

In order to trace and locate survivors for interviews a number of procedures could be followed. In this study one of the most favorable features is that the starting point (knowledge of the information of the death tapes) will provide a path to gain additional information helpful to identifying and locating survivors. Specifically in California nearly all deaths develop a file in the applicable county's registrar-recorder office. This holds true for all but the most destitute (total estate less than $500 in worth). Files are public record and access is not restricted except in cases having significant public notoriety and those enmeshed in court activity of such note that the file will vary.[+] However, information on survivors (heirs) of some sort will be found. Since these files are centralized at single locations in the two counties this will represent an invaluable cost-effective source. Of course as illustrated in Figure 2.2 the name of the surviving spouse (item #13) and the name and address of the individual providing certificate information (item #20) are the most readily available starting points. Furthermore physician identification and place of death (usually a hospital) entries provide other sources of survivor information and/or health/personal history records.[*]

Other tracing methods include letters to usual residence (item #19) with requested post office forwarding, discussions with former address neighbors, property tax and voter rolls (on surviving spouse or information informant), and many other individualized approaches. In all cases the closest survivor or the person with the greatest likelihood of providing complete and

---

[+] The Los Angeles County office was visited and several files selected and viewed. In all cases information on the name and whereabouts of survivors was found.

[*] In fact if hospital personal history records are thorough, it may be possible to develop sufficient information analyses even in the absence of a completed questionnaire.

accurate information will be located (see Section 4.4.1). Furthermore in discussions with NIOSH staff it has been suggested that the social security system may be utilized as an efficient and relatively expedient means of identifying information helpful to locate surviving family. Specifically it may be determined if the family received benefits and where they were sent. This complements other approaches to trace the family.

In Section 4.0 material is discussed related to the design through the data management of the questionnaire. A number of quality assurance procedures are included in this discussion.

2.8 ANALYSIS

While detailed analytic plans are not yet possible to specify, it may be helpful to summarize the basic considerations. Cases and controls will be selected as specified previously from the state mortality tapes. After interviews of survivors are completed, estimates can be made of the time of onset of exposure, length of exposure, and possible extent of exposure. The basic analysis then will look for differences in these exposure indices among cases and controls. The simplest analyses would be from 2x2 contingency tables. This analyses will allow relative risk calculations. Cases and controls can also be compared for difference in means of continuous variables such as length of exposure. RXC contingency table analysis could be done with several levels of exposure. Possible confounding factors such as smoking and occupation may be dealt with by tecnniques such as stratification with procedures like that of Mantel and Haenzel to produce overall relative risk estimates. Some analyses may also be done with matched-pair techniques although the major intent of the proposed matching technique is to insure group similarity.

2.9 CAUSE OF DEATH DISTRIBUTION WITH RESPECT TO AMBIENT ASBESTOS CONCENTRATION - PRELIMINARY SCOPING

The study protocol has been outlined and discussed in the previous sections. It is recommended in addition that some additional data assembly and analyses be undertaken for the purpose of suggesting cause of death categories which may warrant further attention. The basic idea, as discussed below, is to intercompare the distribution of asbestos exposure among various causes of death and determine whether they differ significantly. This may result in the recommendation that a cause of death be investigated more thoroughly.

This approach would be considered at the point that air and water asbestos concentration analyses was completed and exposure indices compiled for the counties. This study component is discussed in Sections 2.6 and 3.0. The result of this mapping will be indices E_A and E_W, for airborne and waterborne exposure respectively, specified for each population center in the two counties. Each index will represent the average media concentration for every population center in Calaveras and Tuolumne Counties. The procedure to be followed for each disease sub-category will be to extract the subject's identification number, sex, age, race, residence and length of residence. Schematically (as illustrated below) we will sort and manipulate each disease sub-category array on the computer. It will be assumed for this study segment that the number of years in the county were spent at the usual residence (item 19A of the death certificate).

Individual Disease Sub-Category Array

Disease Sub-Category #

Subject I.D.	Age	Race	Sex	Residence in County (Y)	Airborne Exposure (E_A)	Waterborne Exposure (E_W)	$E_A + E_W$	YE_A	YE_W	$YE_A + YE_W$

Clearly no consideration would be taken (at this point) of occupation, smoking, drinking, socioeconomics and a host of other usual factors which may play roles in particular disease etiology. However for the purposes of screening, the available data cited above should be adequate to accomplish the objectives of identifying the disease sub-categories which correlate most closely with asbestos concentrations.

From the data arrays illustrated above exposure distributions will be calculated (separetly for male and female for each sub disease category) as a function of each of the six indices - E_A, E_W, $E_A + E_W$, YE_A, YE_W, $YE_A + YE_W$. Statistical analyses of each distribtuion will be conducted as will analysis of variance among them. Assuming all unaccounted-for parameters equal it is clear that themore closely a cause of death correlated with the exposure indices, the greater the priority to consider it further by developing the detailed information cited above (smoking, socioeconomic status, occupation, etc.)

One must be very cautious not to draw strong conclusions from exposure correlation results. Certainly no known causes of mortality known to be associated with high levels of exposure to asbestos, i.e., occupational diseases, will be discarded based on this preliminary screening. It is possible that confounding factors not being accounted for could mask the screening results. Therefore we will not discard lung cancer, mesothelioma, or other known occupational diseases.

It is clear that data omissions will exist since material are derived from death certificates. A troublesome omission would be the residence information. If it is available by inference such as from the notation of the surviving spouse's address, then it will be incorporated. Otherwise the available information will be carried through the computer data base for future investigation and calculations of mortality rates. However no exposure indices would be assigned nor would the subject be included in the computation of disease sub-category distributions if residence information were totally unavailable from death certificates.

The final product of the subject identification will be the data files of subjects belonging to disease sub-categories which show the closest correlation with the exposure indices.

2.10 COMMENTS ON STATISTICAL SAMPLE SIZE

The goal of selecting between 100 and 200 subjects for any given cause of death category is somewhat arbitrary but based upon practical grounds. A sample size of 200 would allow detection of a difference between cases and controls in exposure frequency of 0.15 if the frequency is 0.5 in the control group at $\alpha = 0.05$ and a power of 80%. Under the same conditions if the sample size is 100, the power would drop to < 50%. Thus unless the exposure difference is dramatic (as we might expect in the case of mesothelioma) a sample size of 100 is unlikely to be cost-effective. It should be noted that the above figures are conservative estimates.

3.0

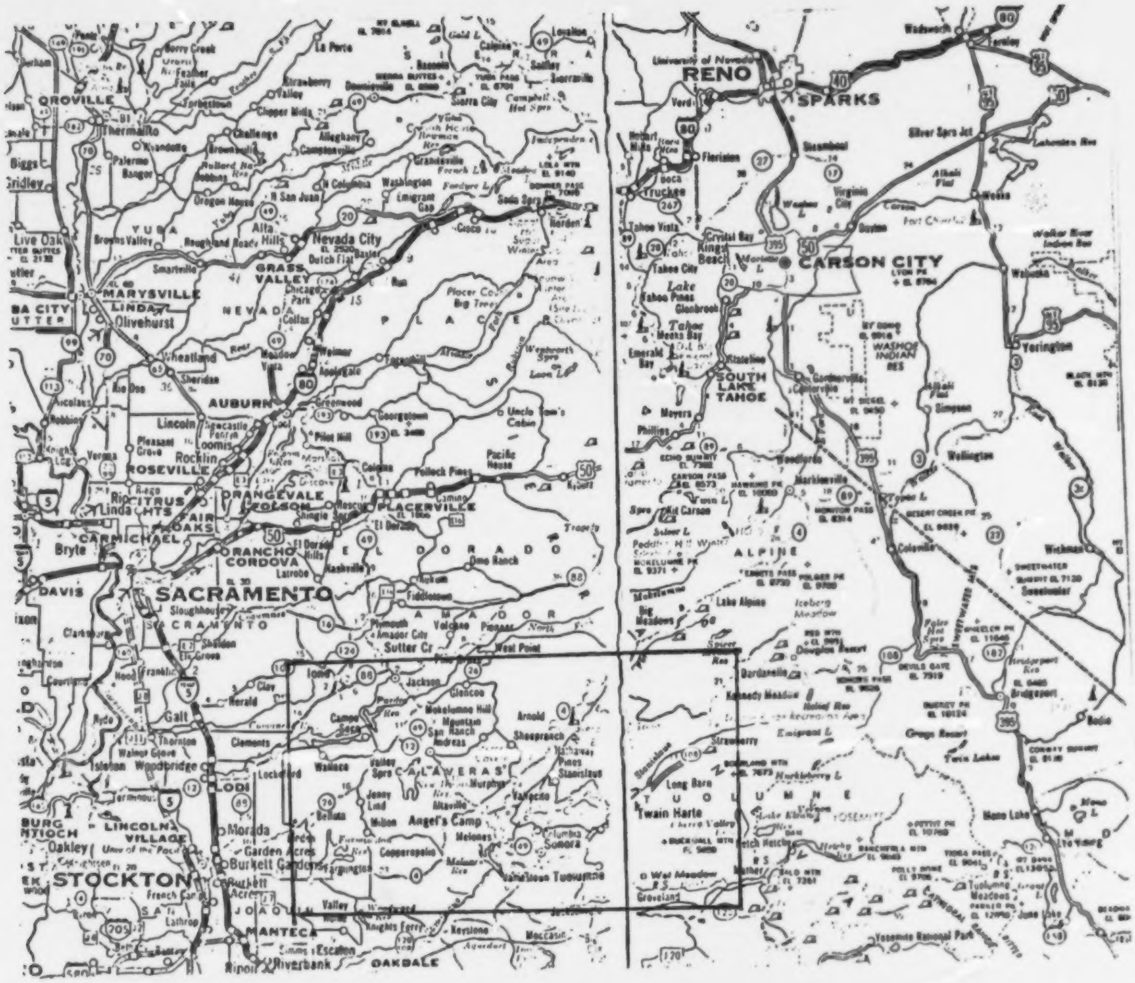
SOURCE INVENTORY AND EXPOSURE ESTIMATION

3.1 OVERVIEW AND CONCLUSIONS

There are two principal areas of California in which asbestos mining and milling activities are conducted. Both were investigated in this study and the anthropogenic and natural sources of asbestos emissions into the environment were surveyed. The large scale area views are shown in Figures 2.1, 3.1 and 3.2. The county areas which constitute these regions are principally rural with cities generally having less than 6,000 population. The only large cities among Calaveras, Fresno, Monterey, San Benito, and Tuolumne counties are located apart from the serpentine areas. The coincidence of asbestos mining and milling with these less urbanized county areas is a factor which favors their study since persons in urban centers are typically exposed to a number of toxic substances in their ambient environment.

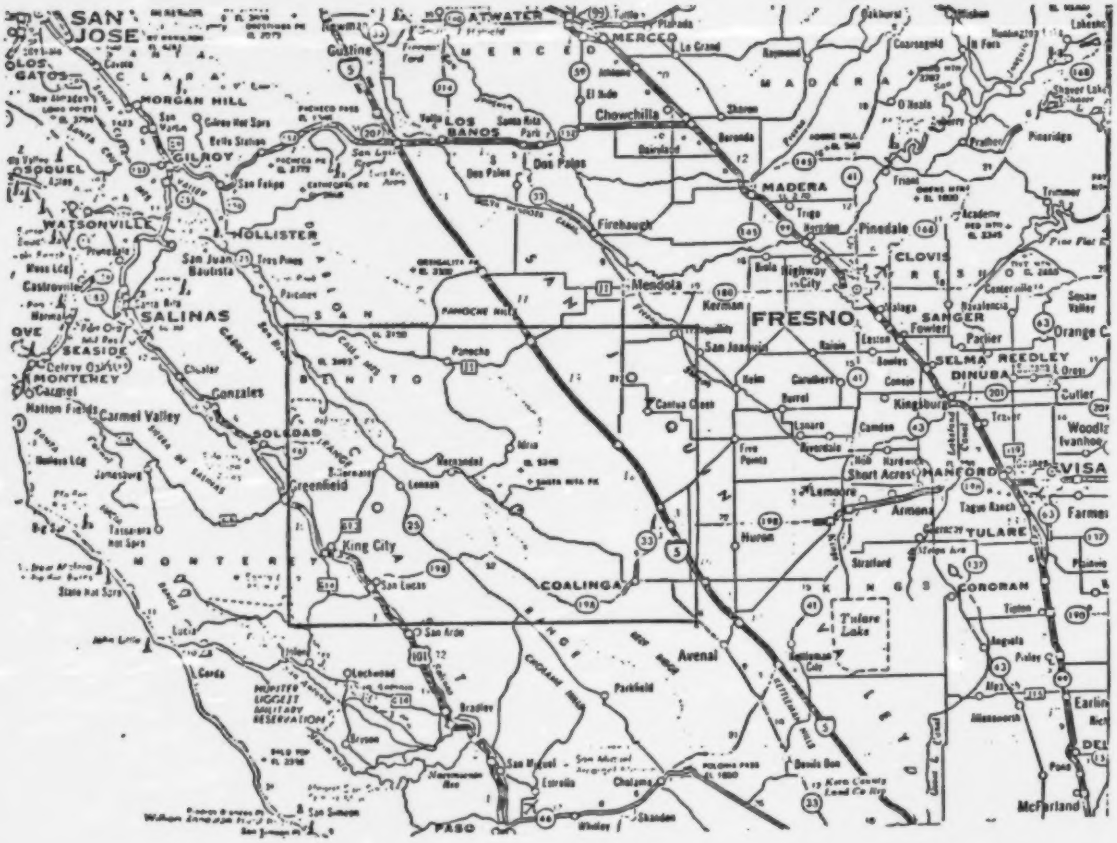
Based upon the synthesis of published literature, a field survey and the review of the limited asbestos monitoring information available, it has been concluded that the airborne and waterborne asbestos levels in particular areas of Calaveras and Tuolumne counties may be elevated with respect to background. In the other principal serpentine area (San Benito, Fresno, Monterey) insufficient information is available with which to estimate exposure. In these latter areas mining activities are relatively isolated from population areas. However, ore transport and milling are in the King City - San Lucas areas. Isolated airborne data taken in King City showed elevated concentrations whereas more extensive mill site data (to be provided by the mill management) appears somewhat lower. The single piece of waterborne assay information is from the Coalinga vicinity and is insufficiently documented to be definitive.

Upwind data taken at Calaveras asbestos during 1965-1967 range from 12-240 ng/m^3 extrapolated to electron microscope concentrations from optical microscopy counts of fibers greater than 5 μm. Ambient concentrations across the country are generally below 10 ng/m^3.


OROVILLE
RENO
SPARKS
Truckee
CARSON CITY
SOUTH LAKE TAHOE
MARYSVILLE
Nevada City
GRASS VALLEY
AUBURN
Lincoln
Rocklin
ROSEVILLE
PLACERVILLE
CARMICHAEL
RANCHO CORDOVA
DAVIS
SACRAMENTO
Jackson
Sutter Cr
Ione
Galt
LODI
Angel's Camp
Sonora
Twain Harte
STOCKTON
MANTECA
OAKDALE
Lake Tahoe
Bridgeport
Mono Lake
CALAVERAS
TUOLUMNE
EL DORADO
AMADOR
PLACER
NEVADA
ALPINE

Reproduced from best available copy.

Figure 3.1. Serpentine Areas of Calaveras and Tuolumne Counties.


SAN JOSE
LOS GATOS
MORGAN HILL
GILROY
WATSONVILLE
HOLLISTER
SALINAS
SEASIDE
MONTEREY
Carmel
Carmel Valley
Gonzales
SOLEDAD
Greenfield
King City
San Lucas
San Ardo
Bradley
San Miguel
PASO
ATWATER
MERCED
Gustine
LOS BANOS
Dos Palos
Chowchilla
MADERA
Firebaugh
Mendota
Kerman
FRESNO
CLOVIS
SANGER
Fowler
SELMA
REEDLEY
DINUBA
Kingsburg
HANFORD
Lemoore
Armona
TULARE
CORCORAN
Tulare Lake
Avenal
COALINGA
Huron
Panoche
Idria
Cantua Creek
San Joaquin
Parkfield
Cholame
McFarland
Orange Cove
VISALIA
Five Points
Pinedale
Riverdale

Reproduced from best available copy.

Figure 3.2. Commercial Asbestos Mining/Milling Area of the New Idria Deposit.

High volume air quality sampler filters have been located in the archives of the California Air Resources Board for a number of sites in Calaveras and Tuolumne Counties. These twenty-four and forty-eight hour duration samples date back to the early 1970s. Their asbestos analysis is practical and may be utilized to provide an exposure mapping of the areas of interest.

Water distribution systems in Calaveras and Tuolumne Counties have been determined. The sources, routes and treatment differ throughout the area. No specific asbestos analyses of the water used for local supply has been uncovered. Based upon several available measurements finding elevated asbestos content in serpentine deposit area reservoirs (which serve San Francisco Bay communities), it is recommended that water sampling and analysis be performed for chrysotile asbestos.

It is concluded, based upon available air and water data, that elevated asbestos exposure to the general population may have occured in areas of Calaveras and Tuolumne Counties.

3.2 CALAVERAS AND TUOLUMNE COUNTIES

3.2.1 General Area Description and Mining Activity

The asbestos-bearing serpentine rock runs in deposits in the western halves of Calaveras and Tuolumne Counties. Figure 3.3 shows these deposits on a state-wide scale, while Figures 3.4 and 3.5 provide the county-wide scale.

Figures 3.4 and 3.5 show the location of population centers with respect to the serpentine formations. The principal mining operation is 7 miles southeast of Copperopolis near the New Melones Dam.

Figure 3.6 shows the geologic detail of Calaveras County. Figure 3.7 shows the mines and mineral deposits (except gold) in Calaveras County. Several types of mines or deposits are location in the serpentine formations: chromite, copper, manganese, and stone.

As of September 1979 there were 18 mining operations in Calaveras and Tuolumne Counties large enough to be regulated by the Mine Safety and Health Agency, U.S. Department of Labor. Table 3.1 lists those operations; the types of operations are summarized as follows: milling - 6 (1 asbestos);

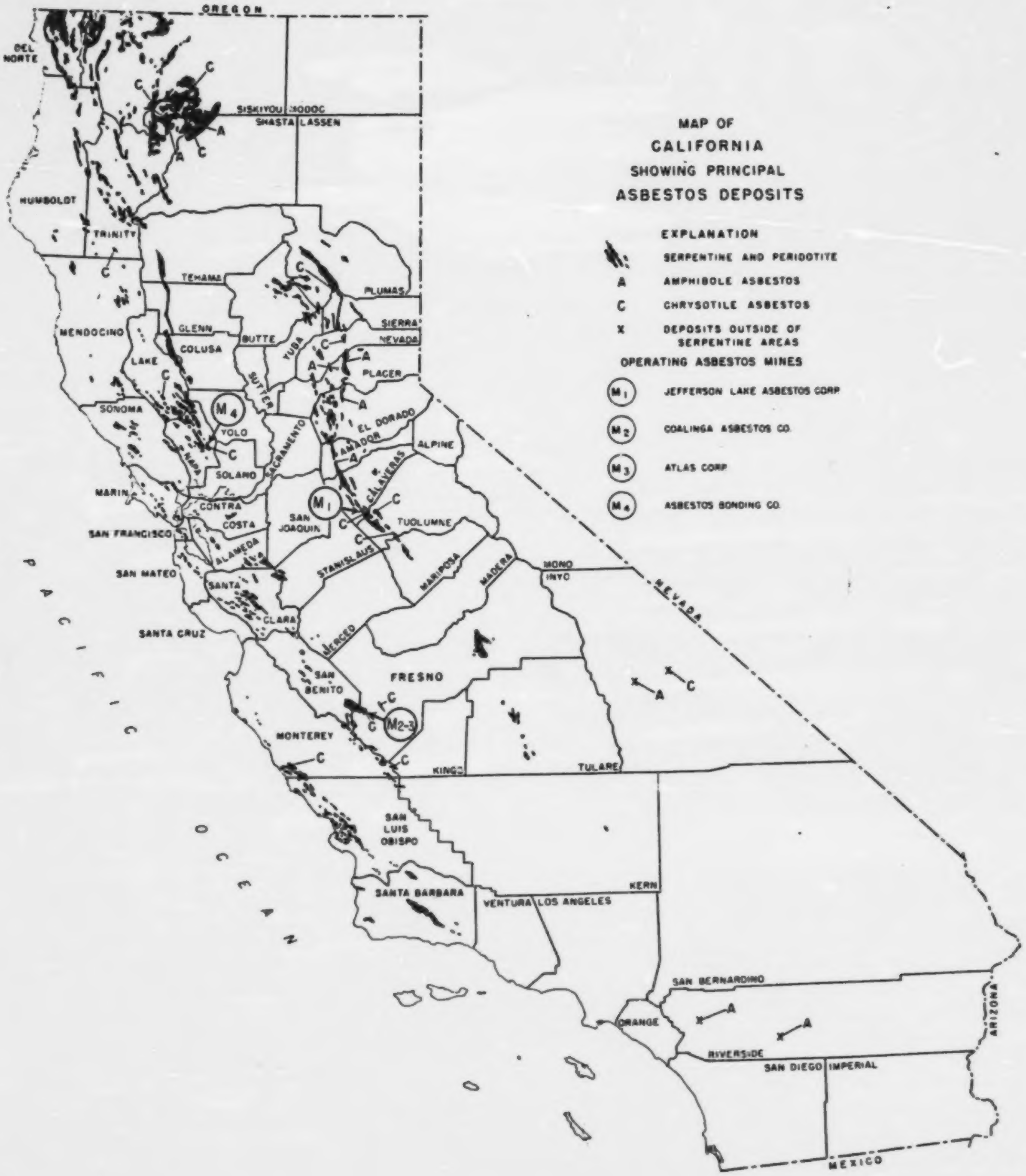

MAP OF
CALIFORNIA
SHOWING PRINCIPAL
ASBESTOS DEPOSITS
EXPLANATION
SERPENTINE AND PERIDOTITE
A AMPHIBOLE ASBESTOS
C CHRYSOTILE ASBESTOS
X DEPOSITS OUTSIDE OF SERPENTINE AREAS
OPERATING ASBESTOS MINES
M1 JEFFERSON LAKE ASBESTOS CORP
M2 COALINGA ASBESTOS CO.
M3 ATLAS CORP
M4 ASBESTOS BONDING CO.
OREGON
NEVADA
ARIZONA
MEXICO
PACIFIC OCEAN
DEL NORTE
SISKIYOU
MODOC
SHASTA
LASSEN
HUMBOLDT
TRINITY
TEHAMA
PLUMAS
MENDOCINO
GLENN
BUTTE
SIERRA
NEVADA
COLUSA
YUBA
PLACER
LAKE
SUTTER
SONOMA
YOLO
EL DORADO
AMADOR
ALPINE
NAPA
SOLANO
SACRAMENTO
MARIN
CONTRA COSTA
SAN JOAQUIN
CALAVERAS
TUOLUMNE
SAN FRANCISCO
ALAMEDA
STANISLAUS
MARIPOSA
MADERA
MONO
INYO
SAN MATEO
SANTA CLARA
SANTA CRUZ
MERCED
FRESNO
SAN BENITO
MONTEREY
KINGS
TULARE
SAN LUIS OBISPO
KERN
SANTA BARBARA
VENTURA
LOS ANGELES
SAN BERNARDINO
ORANGE
RIVERSIDE
SAN DIEGO
IMPERIAL
M1
M2-3
M4

Figure 3.3. Asbestos Deposits of California.

3.4 SERPINTINE DEPOSITS OF TUOLUMNE COUNTY

Geologic Map of California
Sacramento Sheet
Scale 1:250,000
1966
(Second Printing, 1971).

The above mentioned map is in color and oversized:

Map is available from:

Division of Mines and Geology
Ian Campbell, State Geologist
Ferry Building, San Francisco

3.5 SERPENTINE DEPOSITS OF CALAVERAS COUNTY

Geologic Map of California
San Jose Sheet
Scale 1:250,000
1966
(Second Printing, 1977)

The above mentioned map is in color and oversized:

Map is available from:

Division of Mines and Geology
Ian Campbell, State Geologist
Ferry Building, San Francisco

3.6 GEOLOGIC MAP OF CALAVERAS COUNTY

The above map is in color and oversized:

Map is available from:

Division of Mines and Geology
Ian Campbell, State Geologist
Ferry Building, San Francisco

3.7 MINES AND MINERAL DEPOSITS CALAVERAS COUNTY

The above map is in color and oversized:

Map is available from:

Division of Mines and Geology
Ian Campbell, State Geologist
Ferry Building, San Francisco

Table 3.1

CALAVERAS AND TUOLUMNE COUNTY MINES

(as of 9/4/79-MSHA,USDOL)

Company	Code*	Type**	Status***
The Flintkote Co. Cataract Quarries & Mill Vallectio, CC	0400432	CS	A
Calaveras Asbestos Corporation Calaveras Asbestos Mill Copperopolis, CC	0401061	ML	A
Sport Hill Sand & Gravel Sport Hill Pit & Mill Mokelumne Hill, CC	0401961	SG	A
The Flintkote Co. San Andreas Cement Plant San Andreas, CC	0402272	ML	A
Merck & Co. Columbia Quarry Columbia, TC	0402297	CS	A
Bedford Aggregates Keystone Mill Sonora TC	0402347	ML	A
Bedford Aggregates Sonora Green Quarry San Andreas, CC	0402349	CS	T
Sonora Aggregates Corp. Sonora Mill and Quarries Sonora, TC	0402351	ML	A
Calaveras Asbestos Corp. Calaveras Asbestos Pit Copperopolis CC	0402547	OP	A
George Reed, Inc. Table Mountain Plant Jamestown TC	0403126	CS	A

Table 3.1 (continued)

Company	Code*	Type**	Status***
Wood Creek Rock Plant Wook Creek Rock Pit Jamestown TC	0403489	CS	A
Merck & Co. Marine Dolomite Mill Sonora TC	0403493	ML	A
Troy Gold Industries, Ltd. Blazing Star Mine West Point CC	0404242	UG	A
George Reed Inc. Jenny Lind Rock Plant Jenny Lind CC	0404243	SG	A
R.D. Watson, Inc. Watsons Wood Creek Mill Jamestown TC	0404266	ML	P
Gold Trails, Inc. Miller Mine Altaville CC	0404295	UG	A
Troy Gold Industries Ltd Mina Rica West Point CC	0404320	UG	A

---

* Mine I.D. Number

** Type:

UG = Underground
OP = Open Pit
CS = Crushed Stone
SG = Sand and Gravel
ML = Mills

***Status:

A = Active
T = Temporary
P = Periodic

open pit - 1; crushed stone - 6; sand and gravel - 2; and underground - 3. Several of these operations are located near the asbestos mine and mill. They are: Jamestown (3), Sonora (3), and Copperopolis (2).

The three main asbestos deposits (or claims) in Calaveras County are: Jefferson Lake (American, California, Pacific, Voorhees); Turner and Lloyd (Skipper) and Nuner. They are all chrysotile asbestos. There are two main asbestos deposits in Tuolumne County as shown in Figure 3.3. They are both chrysotile asbestos and have not been developed.

Early Mining Data 1900-1959

The early activity at the two active Calaveras County asbestos deposits is described below:

Jefferson Lake (7 miles southeast of Copperopolis)

Time period: 1904-1927

Efforts to exploit were:

- several adits and shallow trenches after 1914
- experimental milling equipment by 1918

The companies involved were:

- California Asbestos Company
- American Asbestos Company
- American Asbestos and Manufacturing Company
- Pacific Asbestos Corporation
- Asbestos Producing Company of California

Time period: 1927-1944

The property was leased to Harry Leach of Oakland. Work ceased shortly afterward

Time Period: 1944

The area was diamond drilled by the Johns-Manville Asbestos Corporation.

Time period: 1952

The deposit was acquired by American Asbestos Mining Corporation, New York City. Some exploration work was conducted including a 30-ton bulk sample being sent to a mill for testing.

Time period: 1959

Jefferson Lake Sulfur Company obtained control. 15,000 linear feet of surface trenching and sinking of 70 diamond drill holes. Cores were milled at a pilot mill.

Turner and Lloyd (4 miles due North of Copperopolis)

Time period: pre-1925

Prospecting activity was conducted.

Time period: 1953

Some work was done and a stock pile made at the junction of a dirt road to the deposit and Highway 4 (at least until 1962-1963). The deposit was developed by numerous small open pits, open cuts, and in the northwest portion an open west cross-cut adit.

Nuner (approximately 1 mile North of San Andreas)

This prospect has remained essentially underdeveloped.

Major Mining Period 1960-Present

After 1959, the Jefferson Lake deposit became an active asbestos mine and mill. A brief chronological history is presented below:

1960	It opened as an open pit mine, with a minor amount of ore taken.
1961	Stripping of over burden was continuing preparatory to open pit mining. Construction of a 2500 TDP ore mill began.
1962	The ore mill was completed in the latter part of the year. The mill operated on an intermittent basis as orders were received (1963 to mid 1964).
1964	In April, Pacific Asbestos Corporation, a subsidiary of the H.K. Porter Company took control. In June there were 13 workers at the mill. In November there were 60 workers at the mill and it was running 15 shifts per week.
1965	The mill was operating at full production 3 shifts/day, 6 days/week.
1966	The crew size was at 95 with ore production of 3000 TPD and 150 TPD asbestos
1967	The crew size was at 135. The firm was beginning to have financial and dust control problems.
1969	There was construction and expansion at the mill including dust control - $1 million during 6 months.
1972	Production was 2000 TPD ore and 100-115 TPD asbestos.
1973	The crew size was 135 at the mill and 35 at the mine.

1974 In April Pacific Asbestos went bankrupt and in June operations were closed.

1975 Calaveras Asbestos Corporation took over and began start up in October.

1976 Production was at 35000 TPY asbestos on operations of 24 hours/day, 5 days/week.

3.2.2 Occupational and Environmental Levels of Airborne Asbestos

Along with the history of the mine and mill, there are considerable data on the occupational exposures to asbestos and a small amount of environmental measurements. In the following sections, the available data are discussed.

Occupational Data

Table 3.2 gives an overview of inspections and resulting requirements by the California safety officials (presently, Mining and Tunneling Unit, DOSH DIR). It can be seen that until Spring of 1972 an incomplete emissions control system existed. Concurrent with much of this period data were taken on the worker exposure levels and a chronological presentation is shown in Table 3.3. This data represents almost an annual evaluation of the worker exposures through the present. In addition there are also the 1973 medical evaluations, lung function, x-ray and physicals, done by Nicholson and Selikoff. The ambient asbestos concentrations which may be derived from these studies are discussed in the following section. The occupational data cited above will not be presented in any significant detail since they relate only to workplace concentrations and cannot be directly extrapolated to provide exposure levels at nearby population centers. However the references provide a firm basis to conclude that occupational exposure was significant through periods of plant operation. Since the epidemiologic study subjects will be drawn from amongst the deceased in the counties, occupational history must clearly be established and considered as an integral part of the data gathering.[+]

Environmental Data

There are several sources of data on environmental levels of asbestos in the Calaveras and Tuolumne Counties. These data are available in two forms:

- The engineering calculations, measurements, and operations of the air pollution control equipment at the mine/mill.

[+] It is anticipated that all individuals having been employed in asbestos mining and milling operations will not be included in the cohort. A roster of employees is available.

Table 3.2

SUMMARY OF SAFETY INSPECTIONS FOR CALAVERAS ASBESTOS BY CALIFORNIA MINING AND TUNNELING UNIT

I. April, 1963 first requirements were written

II. December, 1963 requirements for upgrading the exhaust ventilation system were written.

III. June, 1964 an extensive dust survey was made and as a result orders were again issued.

IV. November, 1964 the company was given an extension in time for compliance with approval of an additional exhaust ventilation system.

V. In March, 1965 these requirements were closed and a complete dust survey was again made in September, 1965, and new orders were again issued for upgrading dust control.

VI. When the company installed an internal vacuum system these requirements were closed in January, 1966, after a closure was issued in October, 1965.

VII. In April, 1967 the company was again written up to provide environment controls for dust, which was completed in May, 1967 with the installation of a bag house.

VIII. Again in February, 1968 the company was written to upgrade the exhaust ventilation system. An order to show cause was issued in February, 1968 with a 2 montn time extension. In April, 1968 the mill was tagged. The tag was lifted in May, 1968 with provisions for continued upgrading of the ventilation system initiated.

IX. The plant remained in operation for approximately 1 year on this basis with dust control inadequate.

X. March, 1969 orders were again written for dust problems and abated in April, 1969.

XI. Again in May, 1969 they were re-written and abated in June, 1969 after the company initiated a large construction contract.

XII. The mill was again cited in August, 1969 and tagged in October, 1969 and was finally closed in January, 1970.

XIII. Late in January, 1970 a complete dust survey was made with several recommendations and citations issued, including the relocation of the crusher on the outside of the mill. Again the plant was tagged in June, 1970 and abated in August, 1970.

XIV. Again in March, 1971 another complete dust survey was made with citations being issued for the bagging area only, and closed in March, 1971. Finally, in October, 1971 new cyclones, hoods, vent lines and a general upgrading was initiated by the company. Progress reports followed on a monthly basis.

XV. Again in March, 1972 requirements were written and in April, a Show Cause issued. In April the company contracted a project for approximately $40.000 to upgrade equipment with correction accomplished with the completion of a new bag house and other equipment.

Table 3.3
RECORDED INSPECTIONS - COPPEROPOLOUS ASBESTOS

	Date	Source	Measurements
*	June 10, 1963	State of California	Occupational in fibers per c.f.
*	1973 (1964,65,66,68,69, 70,71,72 & 73)	Nicholson & Selikoff	Occupational and environmental review
+	August 18 & 19, 1965	Liberty Mutual Insurance Payne & Kruse	Occupational Survey
*	December 1966	USPHS	Occupational Survey Mine and Mill
*	October 31, 1966	California DPH	Occupational Survey
*	August 28, 1967	California DPH	Occupational Survey with upwind and downwind data
*	March 21-24, 1972	U.S. Bureau of Mines	Occupational Survey
+	1973	US MESA Weems, et al.	Occupational Survey
+	1977	Cal/OSHA	Occupational
+	1979	Cal/OSHA	Occupational

---

* Obtained by SAI

+ Reviewed by SAI, held at Cal/OSHA Mining and Tunneling, Sacramento

- Special purpose environmental sampling done by several agencies using a variety of methods.

The air pollution data starts with observations that in 1965 the exhaust stack at the mill was moved to a vertical position from horizontal to prevent dust from being carried over employees. Engineering calculations by the APC Officer of the Calaveras County region, E. Withycombe, were secured for the baghouse installed in 1972-73 (incorporated into the California Air Resources Board Emissions Inventory System). The original baghouse was installed in 1967. Occasional stack samples are available; for example from the dryer stack in 1979: 0.0008 gr/SCF. The most recent engineering control data are available from the present owner and Mr. Withycombe. Emission factors from U.S. Environmental Protection Agency and ACGIH are also available. Examples of these are shown in Table 3.4. Note the importance of milling control efficiency.

The special purpose data is a varied lot. The data are presented below.

1. California Department of Public Health Study 2963, August 28,1967

   Dust samples were collected with Midget Impingers containing water with 5 percent ethyl alcohol. Dust concentrations were determined by a lightfield technique. Table 3.5 presents the measured dust concentrations. Thus total airborne dust rather than asbestos fibers was identified and quantified in comparison to the then applicable maximum allowable concentration. Samples 1, 6, 8, 10, and 13 provide the range of upwind ambient concentrations between 0.1 to 2 MPPCF.

2. United States Air Force, 1971

   Dust samples were collected in the Melones Dam area by Air Force industrial hygienists at two locations upon request of the Bureau of Mines.

	MPPCF
"C" Road Filter Plant	0.18
Visitor Lookout	7.2

   The wind direction is noted as being from the mine to the dam site, a distance of one to two miles. Formal documentation was not available for release. Correspondence between dust sample results and asbestos fiber exposure are discussed in a subsequent section.

3. U.S. Air Force Industrial Hygienist (McClelland AFB Sacramento), March 6, 1972

   Upon request from the U.S. Army the USAF took total dust samples at two construction area sites adjacent to the New Melones Dam. The results were:

Table 3.4

EMISSION FACTORS FOR ASBESTOS FROM MINING AND MILLING[a]

Source[b]	Emission Factor, kg/10^3 kg (lb/ton) of asbestos produced
Mining, total	5 (9 to 10)
Mining	2 (3)
Loading	1 (2)
Hauling	1 (2)
Unloading	1 (2)
Mining, total, 50% control	3 (5)
Milling	50 (100)
Milling, 50% control	40 (80)
Milling, 80% control	10 (20)

[a] The emission factors are based on engineering estimates and no source sampling. These factors cannot be used to quantify asbestos emissions.

[b] Uncontrolled unless otherwise specified.

Source: Emission Factors for Trace Substances, U.S. Environmental Protection Agency, EPA-450/2-73-001.

Table 3.5
MEASURED DUST CONCENTRATIONS

Sample Number	Location	Date	Measured Concentration MPPCF[1]	MAC[2] MPPCF[1]
1	Ambient air-upwind of Mine	9/27/65	0.2	5
2	OBZ[3] Driller (Worthington 3")	9/27/65	28	5
3	OBZ[3] Driller (Worthington 3")	9/27/65	21	5
4	OBZ[3] Shovel Operator	9/27/65	27	5
5	OBZ[3] Shovel Operator	9/27/65	21	5
6	Ambient air--Mine	9/27/65	1	5
7	OBZ[3] Driller (Worthington 3")	8/10/67	3	5
8	Ambient air-upwind(Worthington 3")	8/10/67	.1	5
9	OBZ[3] Shovel Operator	8/10/67	17	5
10	Ambient air-upwind shovel	8/10/67	2	5
11	Ambient air-downwind shovel	8/10/67	5	5
12	OBZ[3] Gardner Denver 6" Drill	8/10/67	3	5
13	Ambient air-upwind GD drill	8/10/67	2	5
14	Ambient air-downwind drill	8/10/67	3	5

---

[1] MPPCF = Millions of particles per cubic foot of air

[2] MAC = Maximum acceptable concentration, General Industry Safety Orders (1967)

[3] OBZ = Operator's breathing zone

	Powder Magazine Site	Trailer Camp Site
6/23/71		89.5
6/25		109
6/27	60.5	103
6/28	152	112
6/29	67.8	
7/15	72.8	117
7/16		70.7
7/17		77.1
7/18		38.1
7.19		42.8

All quantities are expressed in $\mu g/m^3$. Asbestos concentration for ambient city levels are generally found to be in the range of 0.1-6.0 ng/m^3 by Nicholson, 1971. The data cited above are inadequately documented and we have not been able to determine the validity of the $\mu g/m^3$ units (rather than ng/m^3) nor the averaging period used. It is suspected that the levels are for total suspended particulate and as such fall into the mainstream of urban levels.

It is possible that dust loadings could have been measured over short time periods since blasting activity proceeded once or twice daily at the mine site. The readings may have been made as the cloud passed over the sampling site. If, in fact, total airborne dust measurements were taken, there is no clear way that asbestos fraction can be determined without additional information.

4. W. Nicholson and I. Selikoff, 1973

Sampling was done in conjunction with the Air and Industrial Hygiene Laboratory of the California Department of Public Health. Samples were taken at three sites, one assumed to be a control. Site #1 was the public observation station overlooking the Melones dam construction site which is approximately one mile east of the mine/mill property. Site #2 is on the Stanislaus River about one-quarter mile south and west of the tailings pile. The control sample (Site #3) was taken at the Mark Twain Hospital in the town of San Andreas. It was noted that Sites #1 and #2 were sampled over a 24 hour period during which time the winds were relatively calm and of continuously changing direction. The wind characteristics were thought to have directed emissions over a widespread area with no focus from the mine/mill to the sampling site. Analysis was done by electron microscopy. Results were:

Site #	ng/m^3, asbestos
1	10
2	50
3	4

In the data of 49 cities in 1969-1970 (Nicholson, 1971) ranges of asbestos concentration were principally between 0.1 and 6.0 ng/m3.

Literature cited by the U.S. Department of HEW (USHEW, 1978) referenced asbestos levels in 20 urban areas which were considerably higher. Although there is an inadequate statistical basis available from the isolated Site #1 - #3 readings with which to formulate firm conclusions, it is noted that the river site reading exceeds the average concentration in all but 2 of the 20 urban areas.

Emission factors from the large mine/mill operation near Copperopolis would have varied markedly over the period 1960 to the present. Table 3.4 reproduced from the cited EPA document as a rough guide only to appreciate the significance of control upon emission factors. The Emissions Inventory System of the California Air Resources Board contained the following emissions estimates.+

1972

plan	2254	t/year tsp
mining	900	
primary crushing	36	
recrushing and screening	27	
fines milling	27	
dry rock storage	2250	

1978

pit blasting	126
secondary and tertiary crushing	19
asbestos separation and mill grinding	1
dry rock storage	2

During the pre-1970 period emissions estimates would exceed the 1972 value in several categories. Asbestos content of the total suspended particulate from mining and dry rock storage would reflect the ore enrichment whereas the milling processes would have a greater mass fraction of asbestos. Survey data taken by the U.S. Public Health Service (USPHS, 1966) reported asbestos concentrations for occupational exposure in the mg/m3 level. Assay was done using optical microscopy. Extrapolation was provided among measurement

---

+ The 1978 numbers were calculated by E. Withycombe, county pollution control officer. His emissions determinations have been reviewed by SAI. Individual process loss factors were taken from EPA AP-42 and coupled with plant flow rates and also with manufacturing specified baghouse efficiency. No monitoring was conducted or utilized in determining emissions.

units of grains, fiber density and mass density. However further extrapolation would be needed to account for asbestos content ommited by optical microscopy. Sufficed to say that during the 1960's the site could be considered a significant source by today's standards.

The most recent environmental sampling was a comprehensive area monitoring by Gil Wood, USEPA, RTP, North Carolina done in October 1979. The results are pending.

3.2.3 Background: Asbestos in Water - Calaveras and Tuolumne Counties

The water distribution system past and present was delineated for the Calaveras and Tuolumne County areas of interest. In some cases the water source, transport and treatment have remained unchanged for over 50 years. The systems are described below. Discussions with state and county water resource personnel indicates to their knowledge that no asbestos assay has ever been conducted for these water sources.

Calaveras County

Towns in the area of San Andreas (Mokelumne Hill) are served by the Calaveras County Water District. Figure 3.1 shows the overall areas of interest. Figure 3.8 is a portion of the county plate containing the San Andreas water system. The source is at higher elevations from the south fork of the Mokelumne River.

Water is stored in the Jefferson Davis Reservoir (betwen Railroad Flat and Glencoe) and then pumped down to the Mokelumne Hill and San Andreas areas. The system was originally established in the gold rush era and has earthen sections. A treatment system at the Jefferson Davis Reservoir was installed. Figure 3.9 shows area geology. Serpentine deposits are denoted sp. It is not expected that elevated asbestos levels would be developed by transport over the distribution route. Note that the Pardee Reservoir seen in Figure 3.9 supplies the East San Francisco Bay area and has been confirmed to have elevated asbestos levels.

Figure 3-10 illustrates the Copperopolis area to the south of San Andreas. This area is closer to the prime serpentine deposits seen in Figure 3.11 and the mine/mill which is about 7 miles further southeast adjacent to the Stanislaus River. The water source for 50 years (up until 1977) has been Penny Creek. Although unlabeled on Figure 3.10, this source is denoted dam and is immediately adjacent to the town in the northwest direction. This surface water source clearly traverses asbestos bearing deposits as seen in Figure 3.11.

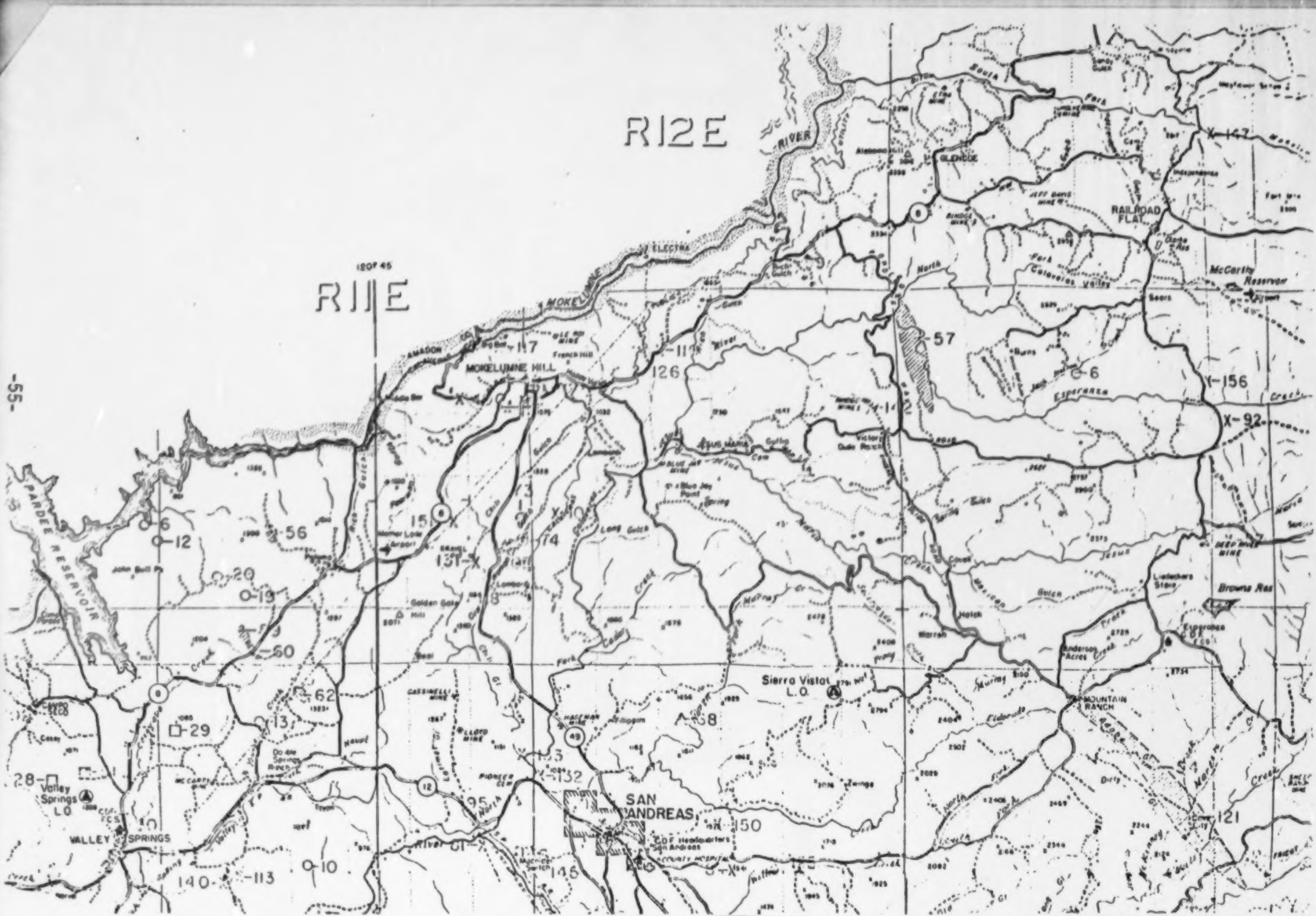

R12E
R11E
120°45
RIVER
MOKELUMNE
ELECTRA
AMADOR
MOKELUMNE HILL
French Hill
GLENCOE
RAILROAD FLAT
McCarty Reservoir
Browns Res
MOUNTAIN RANCH
Sierra Vista L.O.
SAN ANDREAS
CDF Headquarters San Andreas
PARDEE RESERVOIR
Valley Springs L.O.
VALLEY SPRINGS
Esperanza
Golden Gate
Long Gulch
Murray Cr
North Fork Calaveras River
6
12
56
20
19
29
60
62
13
28
10
140
113
15
131
74
8
95
132
145
150
58
57
126
117
147
156
92
121

Figure 3.8. San Andreas Area Map.

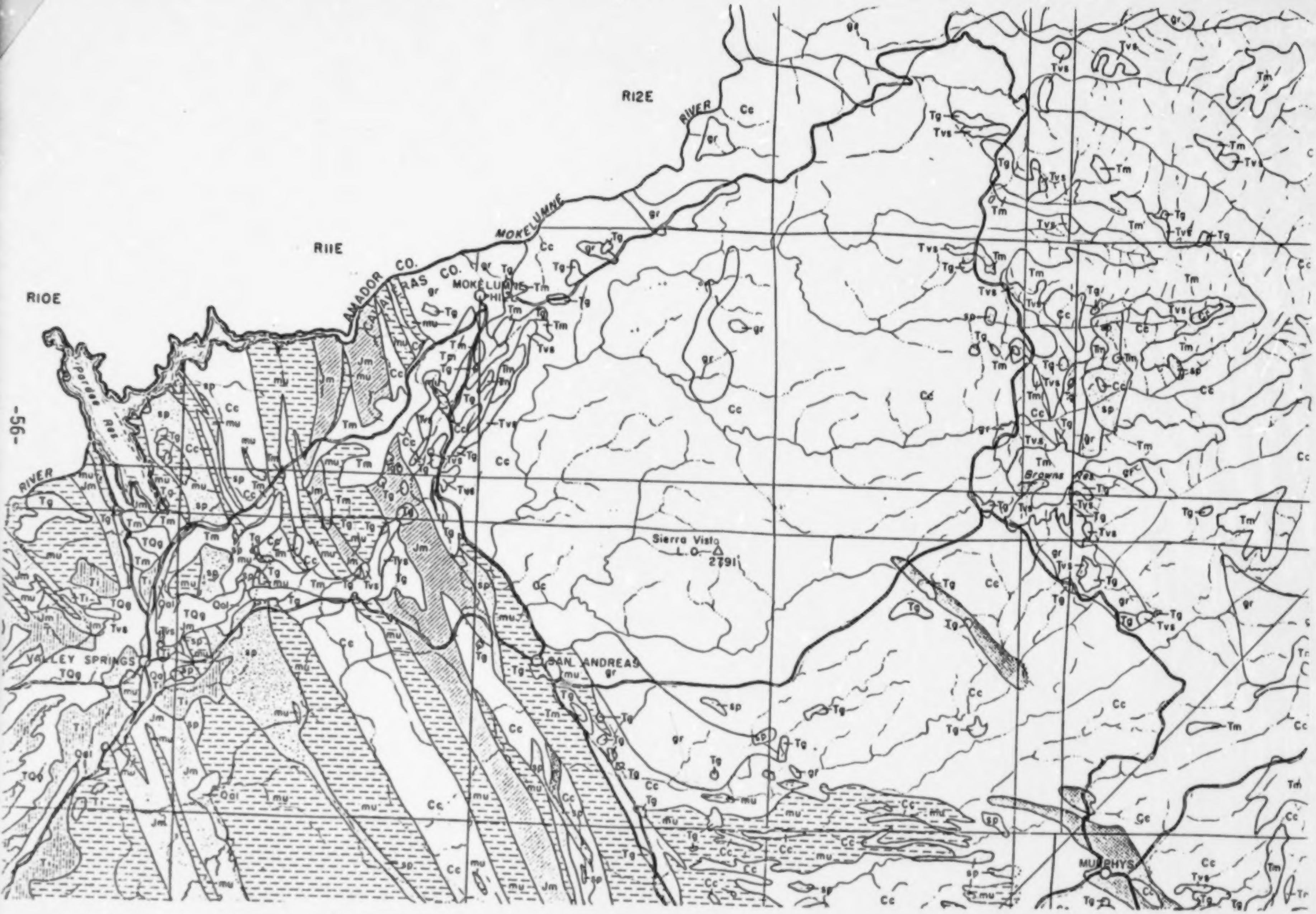

RIOE
RIIE
RI2E
Pardee Res.
MOKELUMNE RIVER
AMADOR CO.
CALAVERAS CO.
MOKELUMNE HILL
Browns
Sierra Vista L.O. 2791
SAN ANDREAS
VALLEY SPRINGS
MURPHYS
RIVER
Cc
Tg
Tm
Tvs
gr
mu
sp
Jm
Qal
TQg
Tr

Figure 3.9. Geologic Map San Andreas Area.

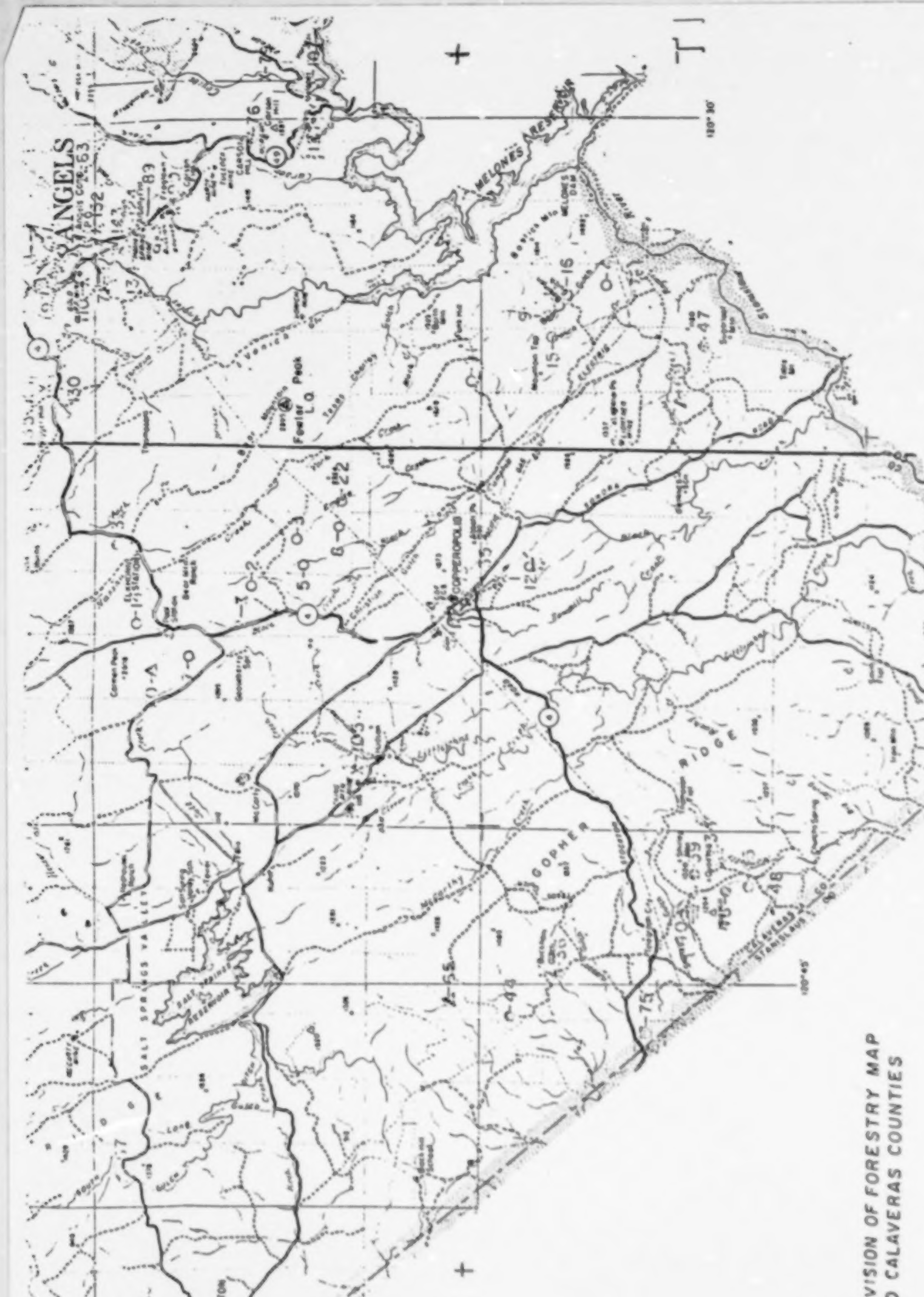
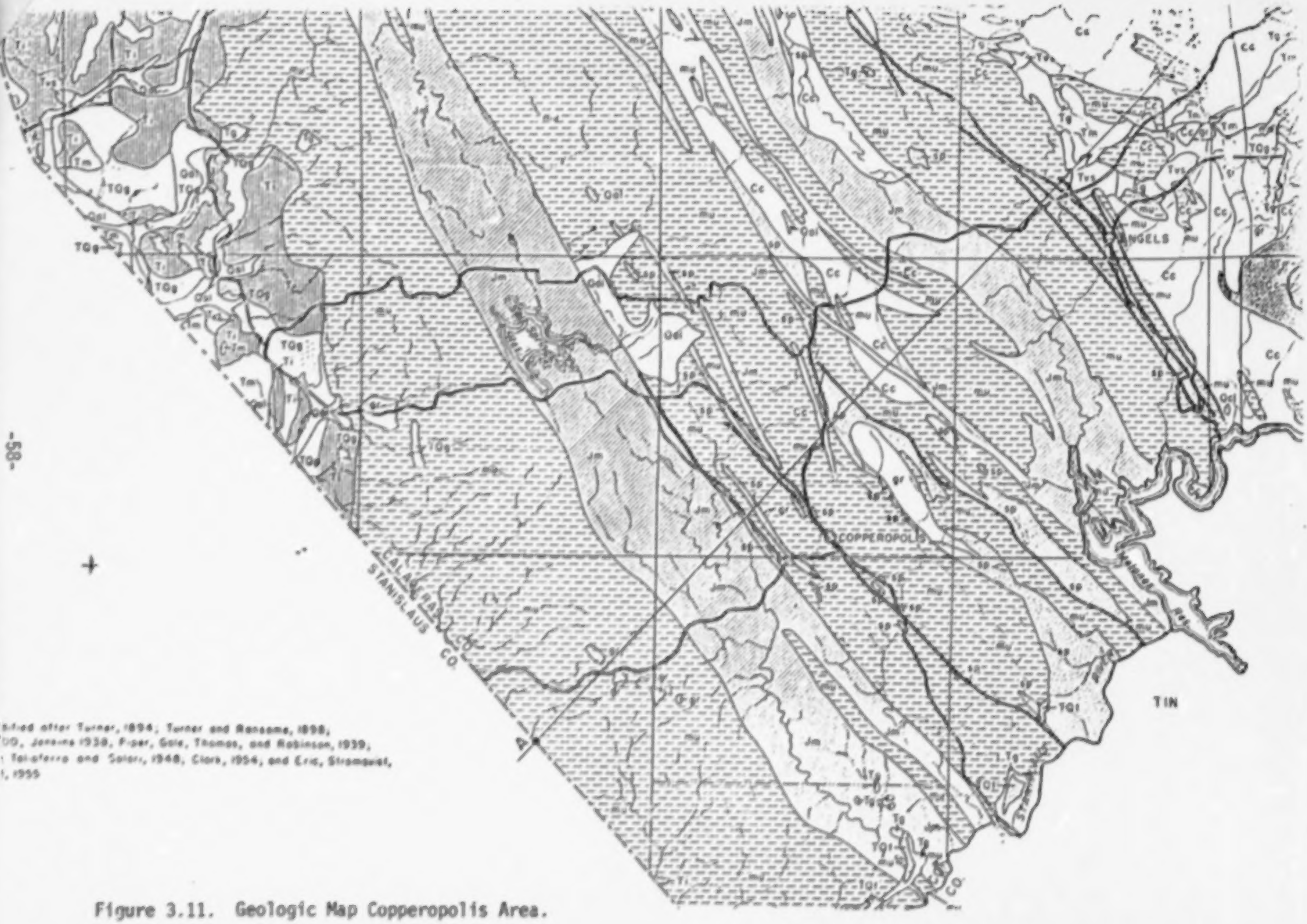

ANGELS
COPPEROPOLIS
MILTON
GOPHER
RIDGE
MELONES RESERVOIR
SALT SPRINGS VALLEY
Fowler Peak L.O.
CALAVERAS
STANISLAUS
120°30'
120°45'
ITE DIVISION OF FORESTRY MAP
IR AND CALAVERAS COUNTIES

Figure 3.10. Copperopolis Area Map.


ANGELS
COPPEROPOLIS
CALAVERAS CO
STANISLAUS CO
TIN
A
Cc
mu
Jm
sp
Tg
TQg
Ti
Tm
Tvs
Qal
gr

ified after Turner, 1894; Turner and Ransome, 1898,
DD, Jenkins 1938, Piper, Gale, Thomas, and Robinson, 1939,
, Taliaferro and Solari, 1948, Clark, 1954, and Eric, Stromquist,
, 1955

Figure 3.11. Geologic Map Copperopolis Area.

Angels Camp and the adjacent area (Vallecito, Murphys, etc.) are served by the Utica Ditch which draws from the North Fork of the Stanislaus River. Figure 3.12 shows the area. Examination of Figure 3.13, the geological map area, leads one to conclude that elevated asbestos levels would be unexpected. Reservoirs are Hunter (near the source), Utica, and Kiefer (directly north of Angels).

Finally, Figure 3.14 shows the Valley Springs area west of San Andreas. Figure 3.15 shows the geology and indicates the local presence of serpentine formations. That area has been served out of a local spring which may contain elevated asbestos content. The Stockton metropolitan area (west of this immediate vicinity as shown in Figure 3.1) is served by the reservoir just south of Valley Springs. The Calaveras River which feeds that reservoir traverses a broad serpentine deposit (as seen in Figure 3.15). Note the Salt Springs Reservoir further south is shallow and only used for agricultural irrigation.

Tuolumne County

Serpentine deposits extend into Tuolumne County and are concentrated in the areas adjacent to the Melones Reservoir, Jamestown and the Chinese Camp (as illustrated in Figure 3.1). Figure 3.16 illustrates the geological survey of the area. Serpentine formations are denoted ub (Mesozoic Ultrabasic intrusive rocks). Water for the entire county is derived from an old mining open ditch system originating at higher elevations in the eastern part of the county. The initial reservoir is Lyons Reservoir. Flow proceeds to a point just northeast of Twain Harte (see Figure 3.1) and forks at that point. One fork to Columbia and the other to Tuolumne (city). The Columbia fork branches again with one leg going to Columbia via a treatment plant and the other through a Pacific Gas and Electric power plant then to the Phoenix Reservoir (seen just above Sonora in Figure 3.16) and then to Sonora. Following Sonora the water is treated and sent to Jamestown. This entire system is a surface water supply run through native earth much of the way. Treatment is done by sand filtration to reduce turbidity. Asbestos levels in these waters are unknown but consultation with EPA water quality researchers indicates that unless water has been treated

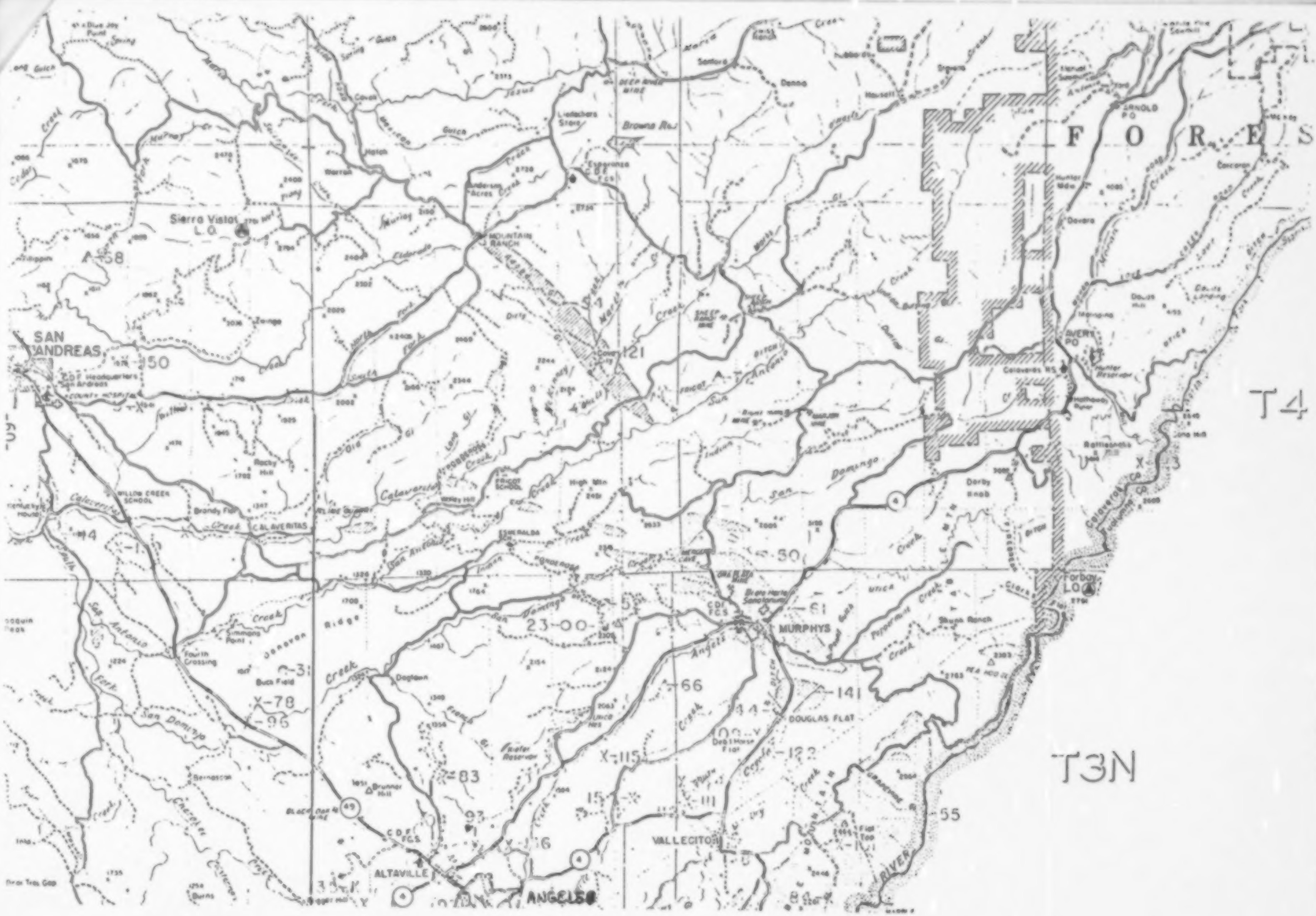

SAN ANDREAS
CDF Headquarters San Andreas
Sierra Vista L.O.
MOUNTAIN RANCH
CALAVERITAS
Fourth Crossing
ALTAVILLE
ANGELS
VALLECITO
DOUGLAS FLAT
MURPHYS
ARNOLD P.O.
AVERY P.O.
Calaveras R.S.
Forbay L.O.
Dogtown
F O R E S
T4
T3N
RIVER
A-58
X-50
121
-50
-61
-141
-122
-66
X-115
23-00
X-78
X-96
-83
93
X-116
55

Figure 3.12. Angels Camp Area Map

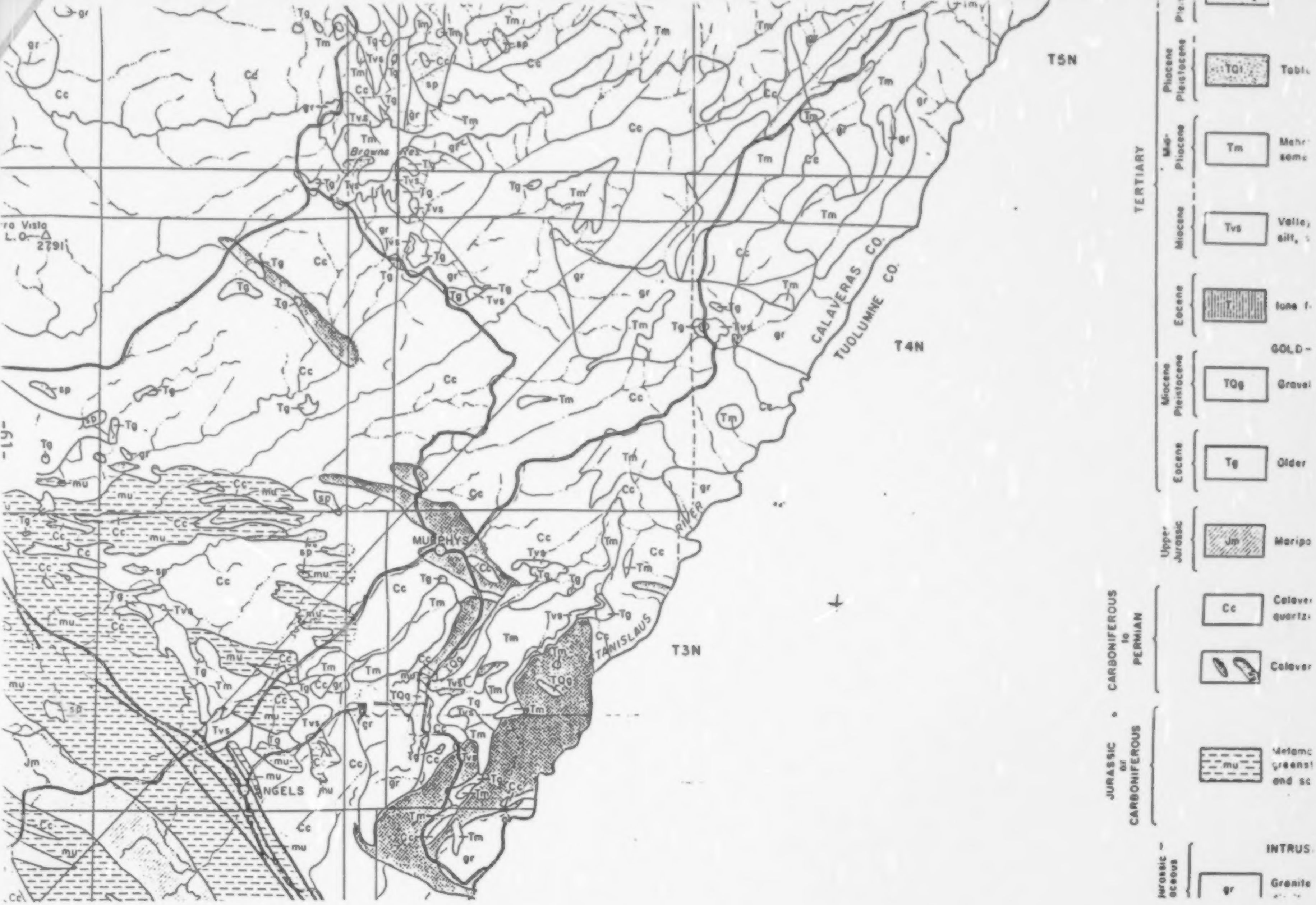

T5N
T4N
T3N
CALAVERAS CO.
TUOLUMNE CO.
STANISLAUS RIVER
MURPHYS
ANGELS
Browns Res
ra Vista L.O. 2791
TERTIARY
Pliocene Pleistocene
TQt
Tabl
Mid-Pliocene
Tm
Mehr seme
Miocene
Tvs
Valley silt,
Eocene
T
Ione f
GOLD-
Miocene Pleistocene
TQg
Gravel
Eocene
Tg
Older
Upper Jurassic
Jm
Maripo
CARBONIFEROUS to PERMIAN
Cc
Calaver quartz
Calaver
JURASSIC or CARBONIFEROUS
mu
Metamo greenst and sc
Jurassic - aceous
INTRUS.
gr
Granite
Cc
Tm
Tg
Tvs
TQg
gr
sp
mu
Jm

Figure 3.13. Geologic Map Angeles Camp Area

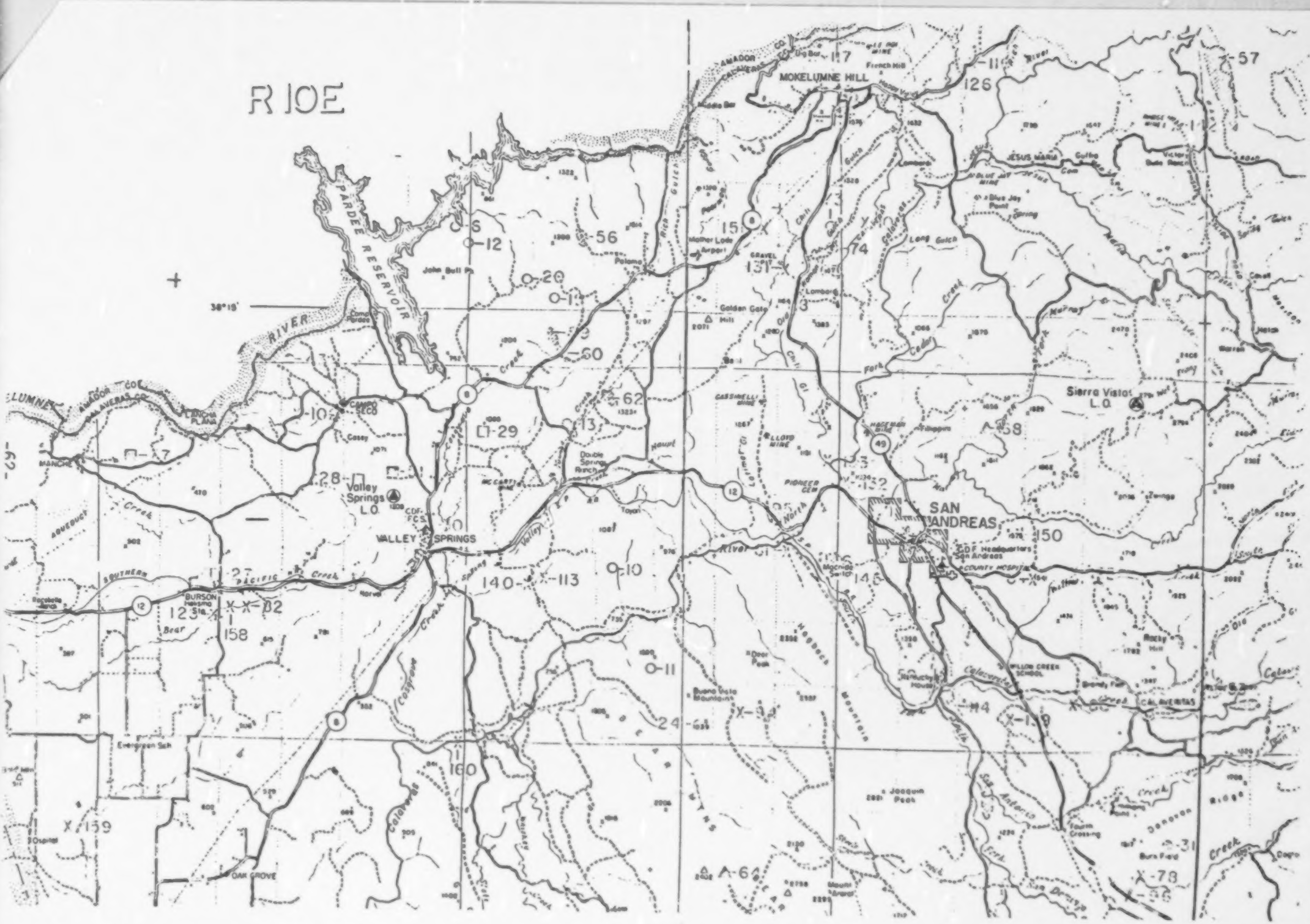

R 10E
PARDEE RESERVOIR
RIVER
AMADOR CO.
CALAVERAS CO.
MOKELUMNE HILL
SAN ANDREAS
CDF Headquarters San Andreas
VALLEY SPRINGS
Valley Springs L.O.
Sierra Vista L.O.
BURSON
CALAVERITAS
Mother Lode Airport
Golden Gate Hill
Double Springs Ranch
John Bull Pk.
Joaquin Peak
Oak Grove
Evergreen Sch.
38°15'
-57
126
117
151
131
74
-56
-12
-20
-60
-62
-29
-13
-10
-11
132
150
145
140
-113
123
158
160
-159
A-58
A-64
X-78
X-139
-31

Figure 3.14. Valley Springs Area Map.

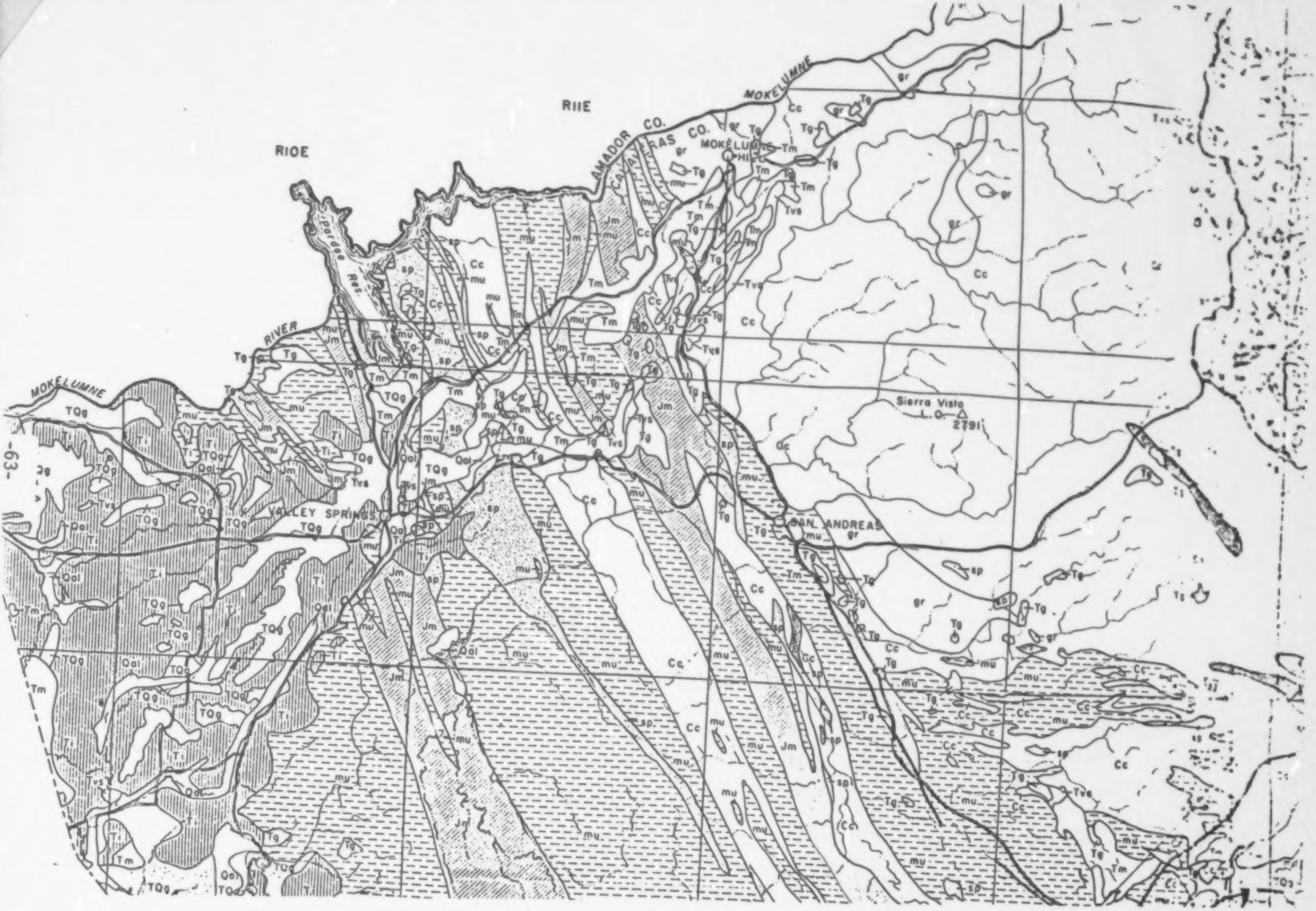
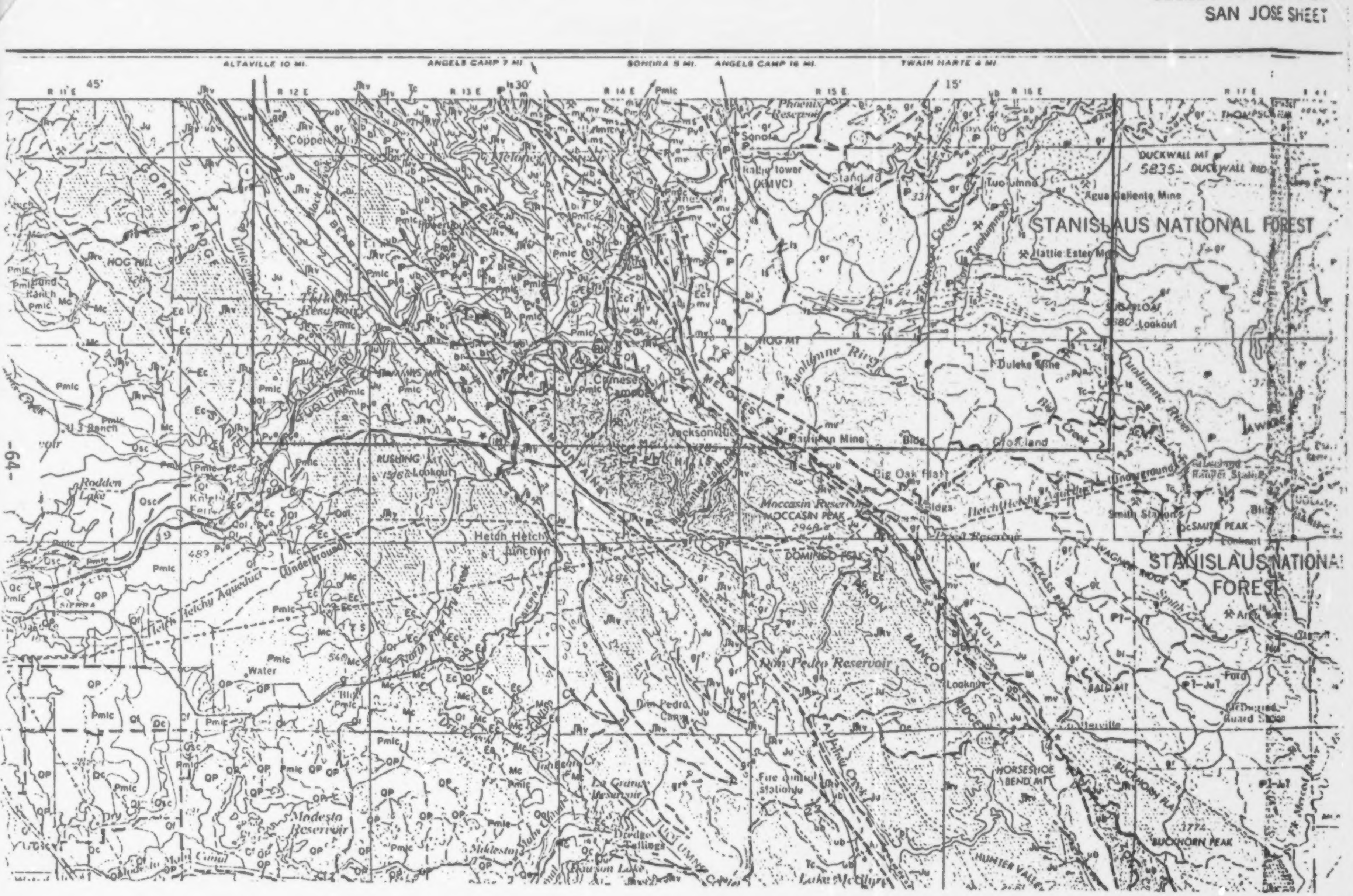

RIOE
RIIE
AMADOR CO.
CALAVERAS CO.
MOKELUMNE
MOKELUMNE HILL
Pardee Res.
RIVER
MOKELUMNE
VALLEY SPRINGS
SAN ANDREAS
Sierra Vista
L.O.
2791
Tg
Tm
Tvs
TQg
Qal
Ti
mu
Jm
sp
Cc
gr

Figure 3.15. Geologic Map Valley Springs Area.



GEOLOGIC MAP OF CALIF
SAN JOSE SHEET
ALTAVILLE 10 MI.
ANGELS CAMP 7 MI.
SONORA 5 MI.
ANGELS CAMP 16 MI.
TWAIN HARTE 4 MI.
R 11 E
45'
R 12 E
R 13 E
30'
R 14 E
R 15 E
15'
R 16 E
R 17 E
STANISLAUS NATIONAL FOREST
DUCKWALL MT
5835
DUCKWALL RID
Agua Caliente Mine
Hattie Estes Mine
SUGARLOAF
3380 Lookout
Phoenix Reservoir
Sonora
Radio tower (KMVC)
Standard
Tuolumne
Copper
GOPHER RIDGE
HOG HILL
Tuolumne River
HOG MT
Duleke Mine
Groveland
Big Oak Flat
Jacksonville
Moccasin Reservoir
MOCCASIN PEAK
2948
Hetch Hetchy Aqueduct
Underground
Hetch Hetchy Junction
RUSHING MT
1568 Lookout
Rodden Lake
Knights Ferry
U S Bench
Water
DOMINGO PEAK
PENON BLANCO
Don Pedro Reservoir
Don Pedro Camp
Fire Control Station
La Grange Reservoir
Dredge Tailings
Modesto Reservoir
Lake McClure
HORSESHOE BEND MT
BUCKHORN PEAK
3774
HUNTER VALLEY
BALD MT
JACKASS RIDGE
WAGNER RIDGE
Smith Station
SMITH PEAK
STANISLAUS NATIONAL FOREST
Groveland Ranger Station
Coulterville
FAULT
Pmic
Jbv
Ju
Mc
Ec
OP
Qc
gr
ub
mv

Figure 3.16. Geologic Map Tuolumne Western County.

or has natural turbidity less than 0.1 turbidity unit (where 1.0 is normally acceptable and a usual quality) then additional treatment to reduce asbestos will not be effective.

Summary: Asbestos in Water

Communities in the serpentine areas of Calaveras and Tuolumne Counties are served by several distinct water distribution systems. It is likely that exposure to asbestos through ingestion of water will differ among the general population according to where they have resided. Since a statistical association between asbestos fiber content in drinking water and the incidence of specific cancers* had been found by Kanarek et al., in San Francisco area communities which in some cases are served by water from Calaveras and Tuolumne Counties, it is necessary to quantify such asbestos exposure among an epidemiologic study cohort in these two counties.

3.2.4 Occupations Associated With Asbestos Exposure - Calaveras and Tuolumne Counties

These two counties are principally rural and have few registered users of asbestos. It is fortuitous that asbestos exposure due to urban related activity (i.e., certain manufacturing, automobile traffic) will be minimal as will petrochemical and most other large scale industrial processing. Occupations, materials and activities associated with asbestos exposure have been discussed and summarized in the literature (USDHEW, 1978). The following is the list of asbestos users in Calaveras and Tuolumne Counties who have registered with the Cal/OSHA Occupational Cancer Control Unit.

Calaveras

- Quyle Kilns - Murphys
- Calaveras Asbestos, Ltd. - Copperopolis

Tuolumne

- Fiberhead Corp., Keystone Div., Jamestown
- Hetch Hetchy Water & Power, Moccasin
- Sonora Union High School District, Sonora
- Summerville High, Tuolumne
- Twain Harte Plumbing & Heating, Twain Harte
- Twain Harte-Long Barn Union School District, Twain Harte
- Woods Creek Rock Plant, Sonora

---

* male lung cancer, female gall bladder, and female cancer of digestive related organs and peritoneum

Area occupations of note which will entail asbestos material handling include: automobile mechanics, road paving and grading contractor employees, certain construction trade worker categories and, of course, certain mining and milling. Two of the registered users of asbestos are other types of mining or milling. Woods Creek Rock Plant in Sonora is a crush stone operation, while Sonora Aggregates is a milling operation. Neither site has been inspected by Cal/OSHA. It is suspected that rock being crushed and milled for aggregate is likely to contain serpentine. Therefore the possibility exists for both worker and public exposure.

Adjacent to Calaveras Asbestos mine is the New Melones Dam site. Construction was underway for approximately twelve years starting in the mid-1960s. In order to excavate for the dam spillway a massive cut was made through the shared serpentine formation. Rock was blasted, gathered and hauled away for use as the dam fill. It must be expected that construction employees would be exposed to asbestos during these operations. Airborne transport of fibers to population centers due to construction activity was never measured.

3.2.5 Potential Environmental Exposure to Asbestos Road Material

A number of occupational diseases associated with asbestos exposure have significant latency periods. This fact has implications to the epidemiologic study design. It is particularly important to account for exposure sources as far back into the past as possible. It is felt that besides exposure to asbestos fibers from the ambient air and drinking water another long-term past exposure source in the counties would be the road material. During the pre-1970 period, many of the area roads were not sealed and vehicular traffic would literally grind the asbestos fibers out of the serpentine road base. As the roads were sealed with asphalt to reduce the dust problems and improve rideability this emission source was eliminated.

Mine Tailings

Of more recent origin are the potential emissions due to use of tailings from the Calaveras Asbestos site. Tailings were used by citizens for fill material, by contractors on the New Melones Dam to cushion the water shafts to the power generators during construction, and by various parties to provide road base material. Obviously since tailings pile material is depleted in asbestos by processing its utilization presents less concern.

Milling

Other mills were noted to be located near population centers in Calaveras and Tuolumne counties. Such activity has been conducted throughout this century and many such sites will remain unknown. To what extent these mills emit particulate from milling serpentine rock and how much asbestos is present in the particulate can not be determined. General ambient levels of airborne asbestos back to the early 1970s may be determined at a number of sampling sites through analyses of archived high volume air filters.

Vehicles

Release of asbestos fibers from brake and clutch facing material does occur. However several assessments have estimated that free fiber release is under 1 percent of content (see Chapter 5, Asbestos: An Information Resource, U.S. DHEW, 1978). This translates to approximately 8,000 pounds of airborne asbestos released annually from buses, cars and trucks which does not drop out on the roadway.

A measurement study by Murchio, et. al., used electron and light microscopy to determine asbestos concentrations at Los Angeles freeway sites and at upwind control points. Concentrations were found to be fairly low and not significantly elevated at the freeway locations. Table 3.6 summarizes the findings. Vehicle traffic in the study areas are much less dense than the Los Angeles freeways and therefore contributions to ambient levels from brake linings and clutch facings should be insignificant. Furthermore the Emissions Inventory System data base of the California Air Resources Board estimated the Calaveras Asbestos site 1972 emissions at about 5,400 tons of total suspended particulate annually. Assuming a 2 to 6 percent asbestos ore content as a reference airborne tsp composition would yield $\sim$ 25,000 lbs/year of asbestos. Clearly such treatment is coarse, however comparisons with nationwide vehicle friction material induced emissions is revealing.

3.2.6 Relationship Between Asbestos Concentrations in Water and Air

The chrysotile asbestos content of Calaveras Reservoir was measured to be 1.1×10^8 fibers/liter by Cooper et al. (Cooper, 1978). Analysis was performed after preparation both by counting (using electron microscope) and by species identification (using morphology and selected area electron

Table 3.6

CHRYSOTILE ASBESTOS FIBERS NEAR LOS ANGELES FREEWAYS

(in fibers per liter)

Location of Freeway	Average Fiber Level		Range	
	Freeway	Control	Freeway	Control
Santa Monica at 4th Street	0.7	0.7	0-5	0-3
Harbor and 146th Street	1.6	1.1	0-12	0-4
San Diego and National	0.8	0.2	0-2	0-1.5
San Diego and 122nd Street	0.5	0.9	0-3	0.9
Composite	0.9*	0.8**	0-12	0-9

Source: Murchio, J.C., W.C. Cooper, and A. DeLeon, "Asbestos Fibers in Ambient Air of California," CARB, March 1973, Contract ARB 4-054-1.

* Fiber Mass Concentration 2.7×10^{-5} μg/ℓ

** Fiber Mass Concentration 4.3×10^{-5} μg/ℓ diffraction). Data reported by Millette et. al. (Millette, 1979) taken in 1975 for the Calaveras Reservoir was 2.4 x 10^8 fibers/liter. Choosing the lower of the two readings the individual's ingested waterborne dose, assuming 2 liter/day consumption is 2.2 x 10^8 fibers. In order to draw conclusions regarding the significance of inhaled asbestos which is subsequently ingested and asbestos which is directly ingested by drinking water it is necessary to correlate air and water concentrations. Since airborne concentrations of asbestos are sometimes determined by optical microscopy, especially older data, such as some found in this study, it is useful to present the relationship between identical air samples analyzed by optical and electron microscopy. L.J. McCabe and J.R. Millette suggest that for every fiber detected by optical microscopy, i.e., fibers greater than 5 microns, 100 fibers would be detected using electron microscopy. McCabe and Millette note the observed correlations range between 15 and 1000 to 1. Thus the ingested level of 2.2 x 10^8 fibers as detected by electron microscopy can be held equivalent to 2.2 x 10^6 fibers greater than 5 microns as detected by optical microscopy.

Ambient concentrations taken in Calaveras county upwind of the Calaveras Asbestos Company (Dept. Public Health, 1967) ranged between 0.1 and 2 million particles per cubic foot of air. These dust samples were collected by midget impingers containing water with 5 percent ethyl alcohol and analyzed by a lightfield technique. The equivalence between impinger counts (which include grains plus fibers) and fiber counts as determined by light microscopy obviously depends upon the specifics of the environment being measured. McDonald estimated (McDonald, 1971) that in the mining and milling occupational group he studied one mppcf of airborne dust was equivalent to 2 asbestos fibers per cc. Ayer et. al. (Ayer, 1965) provided the relationships

fibers/cc equivalent to 1 mppcf by impinger	
Total Fibers	10
> 5 μ Fibers	6
>10 μ Fibers	3

for asbestos textile plants. Additionally measured data for conversion of mppcf to f/cc was reported for the Calaveras mine/millsite in 1971 (Nicholson, 1973) the average of 5 mill site values was 6.4. Furthermore fiber to mass ratios differ markedly across environments. The number of electron - microscope - visible fibers per nanogram varies from 100 to 10,000 (USHEW, 1978).

Proceeding from the upwind value of 0.1 mppcf and using 6 as the mppcf to f/cc (by light microscopy) we have 0.6 f/ci. Taking a respiratory rate of 16 liters per minute for a day yields:

$$0.6 \text{ f/cc} \times 16 \times 10^3 \frac{\text{cc}}{\text{min}} \times 60 \times 24 \frac{\text{min}}{\text{day}} = 13.8 \times 10^6,$$

i.e., approximately 14 million fibers in a day. Assuming one third of the inhaled asbestos is deposited on the respiratory tract surfaces and 90% is cleared and swallowed then this corresponds to approximately 4×10^6 optically accountable fibers per day or 4×10^8 electron microscope detectable fibers. Comparison with the ingested waterborne dose shows them to be of the same order. Thus ingested dose due to inhalation for the air and water levels presented are comparable and the inhalation component to ingestion can not be ignored.

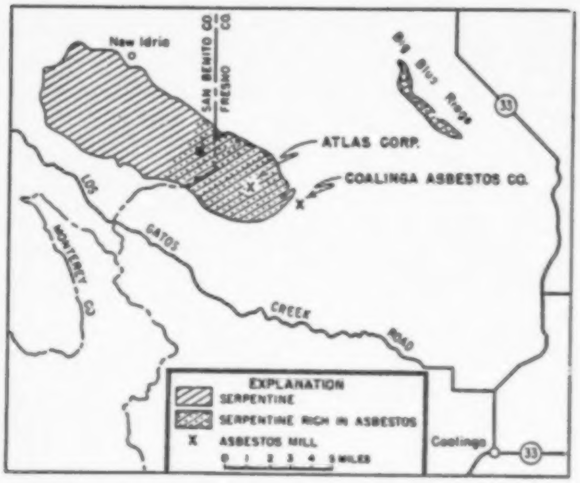
It has been proposed that air and water data be obtained in the populated areas of western Calaveras and Tuolumne counties to establish the ambient exposure to the general population.

3.3 CENTRAL/COASTAL CALIFORNIA ASBESTOS REGION

3.3.1 General Area Description and Mining Activity

A serpentine deposit located at the junction of San Benito and Fresno Counties has been commercially exploited for asbestos since 1959. The mass has a hundred year history of other mining activity including mercury, gems, chromite and magnesite. Figure 3.17 shows a closer view of the deposits and labels two commercial operations. Figure 3.18 shows the larger area around Idria in relationship to the Calaveras-Tuolumne region further north. A third operation owned by Union Carbide has separate mine nad mill locations. The mine is located in the deposit on the San Benito County side while the mill is in King City, Monterey County approximately thirty miles to the southwest. Figure 3.19 is a geological map of the so called New Idria serpentinite.

The serpentinite deposit is dissimilar to most other such bodies in that it consists of a soft friable ore of extremely short fibers of chrysotile with little or no fiber orientation. Although a good deal of literature exists describing the toxicity of various asbestos forms, fiber length and mineral content, no attempt was made in this study to intercompare the toxicity of


New Idria
SAN BENITO CO.
FRESNO CO.
Big Blue Ridge
33
ATLAS CORP.
COALINGA ASBESTOS CO.
X
LOS GATOS CREEK ROAD
MONTEREY CO.
EXPLANATION
SERPENTINE
SERPENTINE RICH IN ASBESTOS
X ASBESTOS MILL
0 1 2 3 4 5 MILES
Coalinga
33

Index map to asbestos deposits and mills in the vicinity of Coalinga, Fresno County.

Figure 3.17

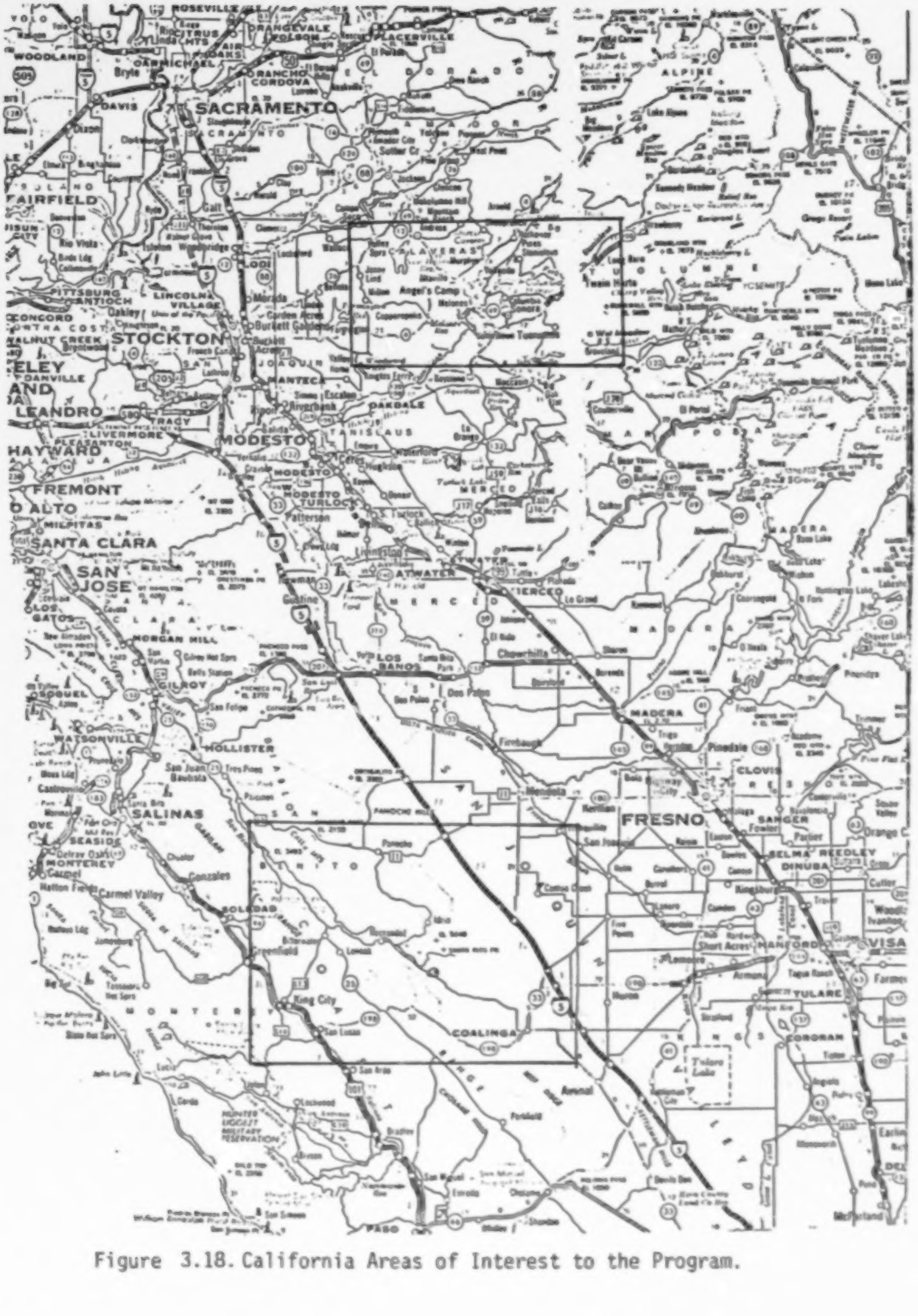


Figure 3.18. California Areas of Interest to the Program.

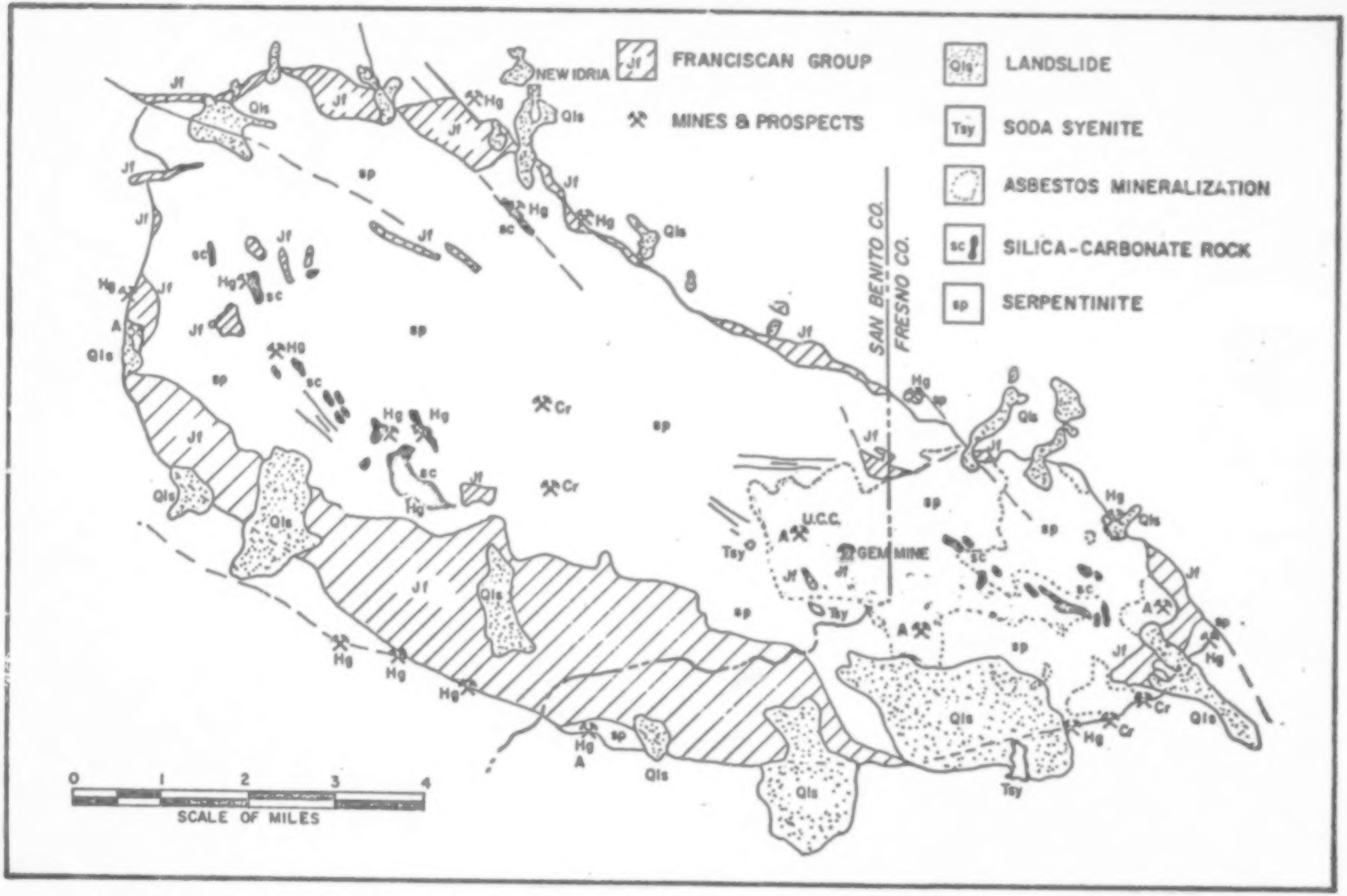

FRANCISCAN GROUP
MINES & PROSPECTS
LANDSLIDE
SODA SYENITE
ASBESTOS MINERALIZATION
SILICA-CARBONATE ROCK
SERPENTINITE
Jf
Qls
Tsy
sc
sp
Hg
Cr
A
NEW IDRIA
SAN BENITO CO.
FRESNO CO.
U.C.C.
GEM MINE
0
1
2
3
4
SCALE OF MILES

Figure 3.19. Geologic Map of the New Idria Mining District, California (from Eckel & Myers, 1946).

asbestos from the New Idria and Calaveras areas. It is noted however that no blasting is required in the New Idria formation which is of nearly 100% asbestos bearing content and has a powder-like release form.

A site visit was conducted to the Union Carbide mill in King City and the vicinities of the operations in the New Idria deposit.[+] An overpowering impression of the mining area is its remoteness. King City is 55 miles away by road (27 by straight-line air distance) and the nearest population center, Coalinga, is 38 miles by road and twenty by air. Individuals have noted plant plumes from the Atlas Minerals site.

3.3.2 Occupational and Environmental Levels of Airborne Asbestos

An environmental survey of the Atlas Minerals and Coalinga Asbestos sites was conducted (USPHS, 1966). Dust concentrations were taken by impinger at occupational breathing zones and general air sample locations. Levels at Atlas ranged between 2.4 and 27.1 mppcf while at Coalinga ranges were 0.8 - 5.8 mppcf. All samples were taken at interior mill rather than mining areas.

Membrane filter measurements were taken at both mining and milling locations with averages summarized below:

	Total Fibers	>5µ	>10µ	Asbestos
	(fibers/cc)			mg/m^3
milling - Coalinga Asbestos	16.8	7.3	2.7	0.73
mining - Coalinga Asbestos	6.4	2.6	1.2	0.51
milling - Atlas Minerals	15.2	9.3	3.8	0.92
mining - Atlas Minerals	6.7	3.3	1.3	0.64
milling - Union Carbide (King city)	6.8	3.5	1.1	0.24

The current occupational limit is 0.5 fibers/cc of >5µ length over an 8-hour time weighted average.

Emissions estimates from the Air Resources Board in total suspended particulates for the Atlas Minerals Milling and ore handling and the Union Carbide mill were:

1972	Atlas Minerals	1139 tons/year
1972	Union Carbide	31 tons/year
1978	Atlas Minerals	56 tons/year
1978	Union Carbide	3 tons/year

[+] The Coalinga Asbestos Company is no longer in active operation. Active sites are the Union Carbide mine and the Atlas Corporation colocated mine/mill.

Unfortunately little ambient asbestos data are available for the mining or milling operations. The only airborne data were taken in the communities around the Union Carbide plant in King City by John (1976) and Weslowski (1975).

King City, downwind of mill	6,000 to 1,600,000 f/m^3	(John, 1976)
King City, upwind of mill	200 to 11,000 f/m^3	(John, 1976)
San Lucas	1,000,000 f/m^3	(Weslowski, 1975)

These levels are among the highest in California ambient air sampling.

The community of San Lucas is several miles south of the mill. It is significant to note that these levels were recorded after control processes were in place at the mill. An additional King City area source would have resulted from the summer season trucking of ore from the mining area to the mill. Trucks proceeded through the main King City streets and after unloading at the mill their tires often were coated with asbestos ore which would have been released during the start of the return trip.

The King City and San Lucas areas are along California Route 101 and have a combined population of approximately 4,000. The area is primarily agricultural and low density with the exception of the main thoroughfare in King City.

Based upon the airborne measurements, the communities of San Lucas and King City would comprise suitable study populations whereas the nearest mining area community - Coalinga - appears to be unlikely to experience elevated asbestos levels. However since the Union Carbide mill has only been active since the mid-1960's it is unlikely to have produced measureable effects. It may be useful to establish an area registry in order to expedite locating and evaluating the community health in the future.

3.3.3 Other Environmental Exposure From the New Idria Deposit

Cooper et al. (Cooper, 1979) conducted air sampling in the Clear Creek area of San Benito County. This recreational area is located within the serpentine deposits. Table 3.7 presents the concentrations of airborne fibers collected during motorcycle rides (Runs #1, 2, 3), at a fixed off road site and by a ranger on patrol. Electron microscope (TEM) counts are presented in Table 3.8 for several of the runs. It is noteworthy that the fixed site level of 0.2 fibers/cc air was taken 12.9 km north of the main road and in the absence

Table 3.7

AIR SAMPLES COLLECTED ON 37 mm FILTERS, ANALYZED FOR FIBERS BY LIGHT MICROSCOPY, USING OSHA TECHNIQUES FROM THE NEW IDRIA SERPENTINE FORMATION

	Position of Rider in Row	Fibers/ Field	mg/m^{3} air (weighed)	fiber/cc air
Run #1	1	.15	0.97	0.9
(3.2 miles in 15 minutes)	2	.89	31.	5.6
	3	.36	19.	2.3
	4	.69	21.	4.3
	5	.37	59.	2.8
	6	.86	61.	5.3
	3*	.21*	1.*	1.3*
Run #2	1	.03	0.0	0.6
(0.75 miles in 5 minutes)	2	.16	12.	3.0
	3	.16	37.	3.0
	4	.26	20.	4.9
	5	.24	13.	4.4
	6	.17	22.	3.1
	3*	.08*	0.4*	1.5*
Run #3 (6.4 miles in 41 minutes)	(Riders not in a strict row)			
	1	.15	1.0	0.3
	(2)	.76	17.	1.9
	(3)	1.4	13.	3.2
	(4)	1.2	11.	2.9
	(5)	.99	9.3	1.7
	(6)	1.3	22.	2.9
	(3*)	.25*	7.8*	0.6*
Fixed Site (48 minutes) 25 ft. N. of road near Indian Flat Campground		.09	0.4	0.2
Ranger (D.L.M.) on patrol in pickup truck (47 minutes)		.20	1.7	0.4

* Closed face personal sampler

Source: Cooper, W.C., et al., Chrysotile Asbestos in a California Recreational Area, Science, Vo. 206, November 9, 1979, 685-688

Table 3.8

COMPARISON OF LIGHT AND ELECTRON MICROSCOPIC COUNTS OF FIBERS COLLECTED ON PERSONAL SAMPLERS WORN BY MOTORCYCLIST NO. 4 AND BY THE RANGER

Sample	Count			Chunks
	Light Microscope	Electron Microscope		
	Length > 5 µm (fibers per milliliter)	Length >5 µm (fibers per milliliter)	Length < 5 µm (fibers per milliliter)	(number per milliliter)
Motorcyclist				
Run 1	4.3	1.0	13	3.3
Run 2	4.9	23	188	61
Run 3	2.9	6.5	42	24
Ranger	0.4	0.1	3.8	0.5

of strong winds. Therefore it is clear that ambient concentrations in this serpentine-rich area are high enough to be of concern. The population density of the entire area is quite low and the concern here is to recreationalists.

Only one isolated water sample was identified for a population area near the New Idria Deposit. A Fresno County region sanitarian, J. Krancher took a grab sample in 1979 from the surface water of White Creek which is above Coalinga and flows out of the Diablo Range. The district has its own laboratory and documented levels at 200 fibers/liter. This extremely low level is suspect based upon comparison with the body of literature which typically slow orders of magnitude greater concentration levels.

3.3.4 New Idria Deposit - Exposure Potential Conclusions

Examination of the Idria area shown in Figure 3.18 gives some idea of its remoteness. Idria itself is a ghost town and the nearest populated community is Coalinga over twenty air miles away. The mining areas appear to be sufficiently isolated to preclude exposure to a significant general population. The Union Carbide mill in King City may have elevated the airborne concentration of asbestos in the only two proximal communities - San Lucas and King City. Approximately 4,000 residents live in the two areas, however, they are widely dispersed. Mill operations would likely represent the most significant source of asbestos. Since operations began fifteen years ago it may be appropriate to establish a cohort of residents and plan to monitor their health status at some future time. Monitoring data from Union Carbide has been promised and is expected to provide airborne concentrations of asbestos at the plant boundaries. Analysis is by optical microscopy.

4.0

QUESTIONNAIRE DEVELOPMENT

In discussing the questionnaire, we distinguish between the subject and the respondent. The subject is the deceased person whose death record is chosen either as a "case" (one who had died of the disease in question, e.g., a form of lung cancer, cardio-vascular disease, mesothelioma) or a control, who is chosen as a comparison. The respondent, on the other hand, is the person who is interviewed, and becomes the source of information on the subject.

4.1 CONSIDERATIONS IN DESIGNING THE QUESTIONNAIRE

Asbestos is such a commonly encountered substance in our environment that a thorough compilation of all sources of an individual's exposure is difficult under the best of circumstances. Arai and Weill (1978) have noted that many patients with asbestos-related diseases are either unaware of the asbestos content of the materials they work with, or unaware that they are working near an asbestos source. On top of this, the long latency of asbestos related diseases means that the disease observed today could be due to short-term exposure 30 or more years ago. These factors make exposure assessment by interview tenuous enough when the diseased subject is being questioned directly. In our case, the questionnaire respondent is not the subject but principally some relative. The problems of awareness and recall are magnified dramatically.

The common procedure for completing an occupational history is to have the respondent list his or her current or most recent job, the previous job, etc; or the first job, next job, etc. (for example, the Mount Sinai Medical Center "Occupational History and Work Exposures" questionnaire). Similarly, residence history can be elicited by asking the subject to list all the places he or she has lived, in order, starting at birth (for example, UCLA's Neurologic Disease Epidemiology Study).

However, in our case, the respondent's knowledge of the subject may be fairly limited, and may be particularly deficient for certain periods of life, e.g., a wife's knowledge of her husband's activities prior to their marriage. Therefore, we have used a "time-line" format, where events are sketched in as they are recalled. This will allow the respondent and the interviewer to fill in details slowly, beginning at any point that is best remembered, and proceed in either direction. It will also allow the use of significant life events (e.g., marriage, birth of a child) as a memory aid. We feel that this mechanism will better handle periods of uncertainty or gaps in knowledge, without being threatening to the respondent. See Section 4.2 for a discussion of the time line.

In order to aid recall and help assign dates along the time line, we propose that the interviewers use the "long-term recollection slide rule," devised for UCLA's study of gastric cancer in Chile, and described by Orellana and Armijo (1978). Once the slide rule is set for the subject's date of birth or date of death, it can instantly equate responses given in terms of calendar years, years of age, or number of years ago. The inventors of this device have found it an extremely valuable tool for stimulating memories in retrospective interviews.

The time line technique should allow a reasonably detailed residence and occupational history to emerge. Moves and job changes are comparatively major events in the life of the subject, and hence more likely to be known and remembered by the respondent. However, there are other important areas (e.g., smoking habits, hobbies, family history of disease) about which the respondent is less likely to provide detailed information. Probing for in-depth answers in these areas is likely to be futile. Therefore, in the questionnaire these questions are asked more simply. We feel that, in many situations, a yes/no response will be as valid and reliable as can be hoped for.

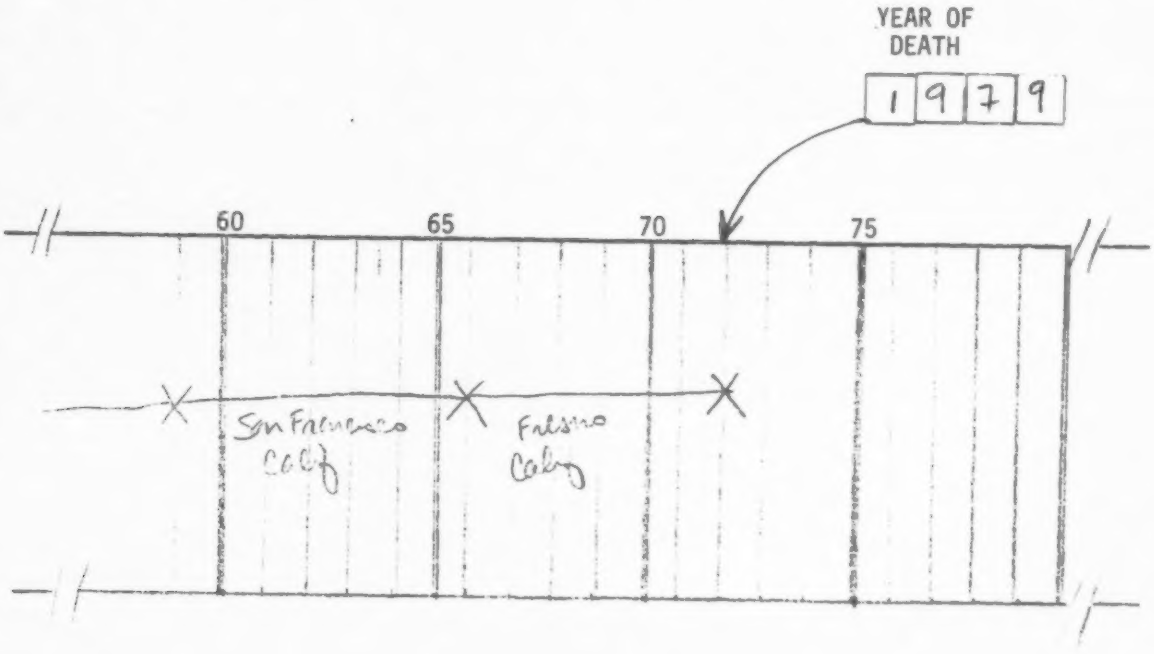
4.2 USE OF TIME LINE

Asking respondents to start listing the subject's more recent (or first) job and work backwards (forwards), giving all details as they go could be intimidating and frustrating. We feel that such a rigid procedure would yield poor quality data. The time line approach is specifically designed to be less threatening, and to make use of a variety of cues to build the information in the easiest manner for each particular respondent.

The interviewing procedure used to fill in the time line will be loosely structured. The interviewer will primarily use standard probes to lead the discussion, but must be free to give and take with the respondent to obtain all the useful information.

After identifying the years of birth and death, the interviewer will use the age-time slide rule to convert calendar years to years of age, if necessary, so that responses can be given in either terms.

The starting point will be flexible, but could be the time of marriage, most recent place of residence, etc. The interviewer will write the name of the town and state, or the occupation, and use arrows to identify approximate beginning and ending dates. For example,


YEAR OF DEATH
1979
60
65
70
75
San Francisco Calif
Fresno Calif

The interviewer and respondent can then work either forward or backward in time, begin at a new place, etc. If exact dates cannot be recalled, the respondent will be urged to give a good estimate. Periods of unknown residences or jobs should be recorded as "unknown." Periods of retirement or unemployment, or work as a homemaker should be recorded as such. It may also be useful to record other life events of either the subject or respondent, such as date of marriage or birthdates of children. Placing these events on the time-line should serve as reference points to the respondent, and enable better recall of dates and places. No details will be collected at this point. The goal is simply to fill in all gaps as far as possible, and provide the respondent with appropriate memory cues to allow for later collection of details.

The interviewers will be trained to probe for significant events (in terms of asbestos exposure) such as jobs during wartime, work in shipyards or docks, or military service. During the pretesting phase, we can also decide whether a specific list of asbestos related jobs would be useful.

After the time line has been completed, the interviewer will then return to the important areas such as the occupational history and probe for details in a standard approach. For instance, after completing the time line and identifying all occupations and dates the respondent can remember, the interviewer can start with the last (most recent) job and work backwards in order, as in most standard job history questionnaires, and elicit the detailed job titles and duties.

The coding of data from the time line is flexible. Every job and residence through life can be coded with beginning and ending dates. Or only residences in high asbestos areas and jobs with probable exposure can be coded.

4.3 REQUIREMENT FOR COMPLETION OF THE QUESTIONNAIRE

The questionnaire draft completed at this stage must be regarded as preliminary. Further effort will be required to mold it into final form, for the following reasons:

First, this draft of the questionnaire consists of questions only on the basic set of information which would be needed in any future study design. It is not possible to include all the necessary questions before formally deciding upon the causes of death to be chosen for study. For example, a study of heart disease deaths should include additional questions such as the subject's height, weight, history of hypertension, and family history of heart disease. In a study of mesothelioma deaths, however, these questions would be of little value. Therefore the complete array of covariates and potential confounders cannot be built into the questionnaire at this time.

Second, because of the inherent difficulties in eliciting a detailed history about a deceased subject from a surviving next of kin, the main body of the questionnaire must be conducted in the form of loosely-structured interview. A suggested layout and interview guide have been provided, including certain probes and cues.

Certain sections of the questionnaire have been pretested on members of the project staff and associates, but no formal testing or tabulation has been performed on the entire instrument. We feel that extensive pretesting will be required, using respondents and interviewers of similar age and sex as would be encountered in the project itself, before the interview format and history-taking technique can be finalized. +

Additional pretesting will be required to modify the present face-to-face interview format into a telephone format, since it is anticipated that many interviews will have to be conducted by telephone.

It is also premature to establish strict coding formats. Except where coding is obvious (e.g., birth dates, or yes-no responses), provisions for coding have been omitted from this draft of the questionnaire.

+ Ideally an attempt at actual validation of the questionnaire should be done by interviewing current "subjects" to get the "true responses" and their spouses.

4.4 INFORMATION RECORDED BY THE QUESTIONNAIRE

We have established four areas of information that the questionnaire needs to address:

1. Respondent's knowledge of the subject
2. Residence history
3. Potential confounding variables (including occupational and other environmental exposures, smoking, family history of disease)
4. Demographics

The preliminary questionnaire draft is reproduced in Section 4.5.

4.4.1 Respondent's Knowledge of the Subject

We must be prepared for difficulties in locating suitable respondents for a given case or control subject. Ideally, the respondent will be a close kin of the subject, such as a spouse, son or daughter. But it may sometimes be necessary to use a more distant relative or associate. In any event, we cannot expect that all respondents will have equal knowledge and recall about the subject. Different relatives or acquaintances often differ in the extent of their knowledge about the subject. Data from the Survey Research Center, University of Michigan, indicate that a subject's spouse, parents, and other relatives differ significantly in their reporting of hospitalization and physician visits (Cannell et al., 1977). Therefore, the questionnaire records

- The relationship of the respondent to the subject - Question 1
- Information about the subject that can be validated from the death certificate - specifically, the subject's date of birth (Question 2), place of birth (Question 7), date of death (Question 3), and age at death (Question 4). Comparing the resondent's knowledge of the subject.
- The length of time the respondent has known the subject. This will be ascertained from the Acquantance Time Line (Question 6). The time line will not only show the length of time the respondent has known the subject, but also over what years or stages of the subject's life (e.g., entire lifetime, young adult life only, middle-aged years and later, etc.).

4.4.2 Residence History

The subject's residence history will be recorded on the Residence Time Lime (Question 7). The questionnaire asks for city and state, or city and country for residences outside the U.S. As explained in Section 4.2, the time line format will allow the respondent to sketch in places the subject has lived, in forward or reverse chronological order, or in pieces as they are recalled.

It is unreasonable to record accurately every town or community the subject had stayed in throughout life. Yet, as demonstrated in the retrospective study by Milne (1976), as little as one year's exposure to asbestos thirty years ago may be sufficient to cause mesothelioma. In this draft, we have settled on recording only places the subject had lived for six months or more.

4.4.3 Potential Confounding Variables

While residence (and possible proximity to community asbestos sources) is the main variable of interest, equally important are other exposures or characteristics of the subject that may be associated with the disease in question (potential confounders). As stated in Section 4.3, the full range of potential confounders cannot be included in the questionnaire until we have established the diseases for study.

The Occupation History Time Line (Question 8) will record occupations by job title, and some idea of duties and possible hazardous expousres will be obtained by probing (Question 9).

Exposure to asbestos or other cancer causing agents through occupation, hobbies, or other contacts, are assessed by:

- o Question 10 - Possible exposure to asbestos through construction-related activities.
- o Question 11 - Possible exposure to asbestos through work on automobiles
- o Question 12 - Possible exposure to asbestos or other hazardous substances through living near a factory, mine, or shipyard
- o Questions 13, 15C & D, 16C & D - Possible exposure to asbestos or other hazardous substances through contact with a working family member.

A brief smoking history will be ascertained through Question 14. This smoking history is not as detailed as one would ideally want. We are faced with the problem of recording histories in the third person. But we feel that these questions will record the subject's smoking habits as reliably as the respondent is likely to recall.

Because certain cancers and heart disease appear to have a strong genetic component in their etiology, it is desirable to gather some information on the subject's familial occurrence of these diseases, even if the respondent is only able to provide information on the subject's parents. The cause of death of the subject's parents is asked in Questions 15 and 16. Although this method of gathering a family history is admittedly crude, we feel that more detailed data are not likely to be elicited reliably.

Other potentially confounding factors for specific diseases, such as alcohol consumption, obesity, and hypertension have not been included in the preliminary draft. Questions on these subjects will be added as necessary depending upon the choice of diseases for study.

4.4.4 Demographic Variables

Some demographic variables that can influence cancer and heart disease risk will be obtained from the death certificate, and willserve as matching variables in control selection. These are age, sex and race.[+]

A measure of socioeconomic status can be determined from the questionnaire using subject's educational level (Question 5) and occupational history (Question 8 and 9).

We also feel it is necessary to characterize to some extent the respondent. The respondent's age or education, for example, may influence his or her responses. Questions 18, 19, and 20 record the respondents' birthdate, major occupation, and education, respectively. The respondent's race and sex can be determined by observation at a face to face interview.

This is the minimum amount of information that should be recorded for each respondent. We do not feel that respondents would be willing to provide more detailed information about themselves.

[+] Race will be eliminated as a confounder by restricting the study to whites only.

4.5 ASBESTOS QUESTIONNAIRE DRAFT

I am going to start by asking you some general questions about
Mr. Mrs. Miss ____________________.
Name of Subject

1. First of all, what was Mr. Mrs. Miss ____________________'s relationship to you? (RECORD)
(e.g., SPOUSE, PARENT, SIBLING, ETC.)

2. What was the date of his/her birth?

______ MO ______ DAY ______ YEAR

3. Do you know the date of Mr. Mrs. Miss ________________ death?

______ MO ______ DAY ______ YEAR

4. That would make him/her about how hold when he/she died?

(RECORD) __________

5. What was the highest grade in school he/she finished?

1 2 3 4 5 6 7 8 9	(GRADE SCHOOL)
9 10 11 12	(HIGH SCHOOL)
13 14 15 16	(COLLEGE OR POST HIGH SCHOOL TRAINING)
17	(SOME POST-COLLEGE EDUCATION)
18	(MASTER'S DEGREE)
19	(DOCTORATE DEGREE)

I need to record, as accurately as possible, the different places Mr. Mrs. Miss __________________ had lived, and the jobs he/she had held during his/her life. We are going to use this form to put together a life history of Mr. Mrs. Miss __________________. We will start by writing the year of his/her birth on the left side of the time line, and the year of his/her death on the right. The numbers along the top refer to Mr. Mrs. Miss _____________'s age. Along this time line, we will fill in the details as best as you can recall them.

6. ACQUAINTANCE

To start with, when did you first come to know Mr. Mrs. Miss _____________? How long did you know her/him?
(RECORD ON ACQUAINTANCE TIME LINE)

7. RESIDENCE

Let's try to record the different places he/she lived over the years. For each place of residence that we talk about, I would like to know the city if possible, and the state, or the country if it's outside the U.S. I'm only interested in towns Mr. Mrs. Miss ____________ lived in for 6 months or more, not places he/she might have just been visiting. Let's begin with where Mr. Mrs. Miss was living at the time of his/her death. How long had he/she lived there? Do you know where Mr. Mrs. Miss ______________ was born? How long did he/she live there?

(CONTINUE FILLING IN RESIDENCE TIME LINE, USING APPROPRIATE PROBES, SUCH AS, "Where did he/she move to next? Do you know where he/she lived before that?")

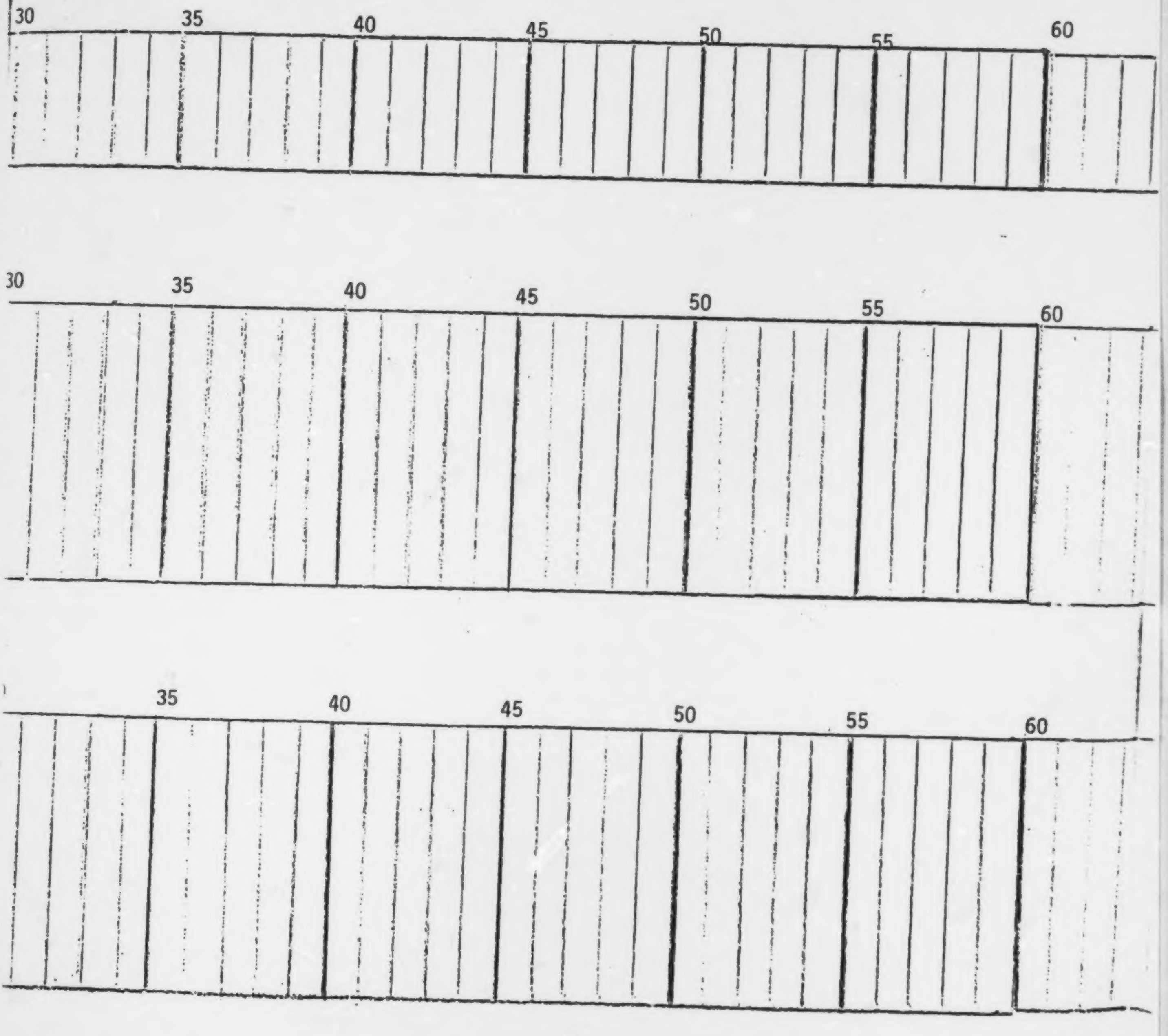
YEAR OF BIRTH

☐☐☐☐

	5	10	15	20	25
ACQUAINTANCE HISTORY					

	5	10	15	20	25
RESIDENCE HISTORY					

	5	10	15	20	25
OCCUPATIONAL HISTORY					



YEAR OF DEATH

☐☐☐☐

60
65
70
75
80
85
90
60
65
70
75
80
85
90
60
65
70
75
80
85
90

89-6

8. OCCUPATION

Now that we have put down the places that Mr. Mrs. Miss had lived, I need to list the different occupations or jobs Mr. Mrs. Miss held. Right now, I'd just like to know the occupation or job title. I'll record any details that you can remember about these jobs later.

To start with, what was Mr. Mrs. Miss _____________'s main occupation during most of his/her adult life? About when did he/she begin this? How long did he/she work at this occupation? What was he/she doing at the time he/she died?

(CONTINUE FILLING IN OCCUPATION TIME LINE, USING PROBES SUCH AS, "What jobs did he/she hold before this? Did he/she ever serve in the military? What branch of the service? Do you know about any part-time or summer jobs he/she may have had as a teenager, or while going to school?")

9. Now I would like to talk about these occupations in more detail. For each of the jobs that you've mentioned, I would like to know what type of work was involved, and whether or not you know of any materials or substances used in this job that might be hazardous to a person's health. Let's start with Mr. Mrs. Miss __________________'s last occupation. (REFER TO TIME LINE)

9A. Do you know what type of work this was, or what duties were involved?

DESCRIPTION:

Do you know if there were any hazardous materials used in this job?
IF YES, RECORD DETAILS:

CONTINUE WITH NEXT PREVIOUS JOB

9B. DESCRIPTION:

HAZARDS:

9C. DESCRIPTION:

HAZARDS:

9D. DESCRIPTION:

HAZARDS:

9E. DESCRIPTION:

HAZARDS:

9F. DESCRIPTION:

HAZARDS:

9G. DESCRIPTION:

HAZARDS:

9H. DESCRIPTION:

HAZARDS:

In this next section of the questionnaire, I will be asking some more specific questions about Mr. Mrs. Miss _______________'s activities. Some of these we may have already talked about, but it's important that I get any information you might be able to provide.

10. To your knowledge, did Mr. Mrs. Miss _____________________ ever work around the house doing repairs or reconstruction?

YES _________ NO _______ DON'T KNOW ______

IF YES:

10A. Did he/she do such work just occasionally, or did he/she spend a lot of time doing repair or reconstruction work, either on his/her own home or someone elses?

OCCASIONALLY_______ A LOT OF TIME______ DON'T KNOW___

10B. Did he/she remodel houses as a hobby?

YES_________ NO_______ DON'T KNOW ______

10C. Did he/she ever help build a house?

YES________ NO______ DON'T KNOW______

11. Did Mr. Mrs. Miss ______________ ever do repair work on automobiles?

YES _______ NO _______ DON'T KNOW ______

IF YES:

11A. Was this just simple work like tune ups, or did he/she do more difficult repairs like replacing brake linings or clutches?

SIMPLE ______ MORE DIFFICULT_______ DON'T KNOW_____

11B. Did he/she spend a lot of time repairing or modifying cars as a hobby?

YES ________ NO _______ DON'T KNOW _____

12. To your knowledge, did Mr. Mrs. Miss ____________________ever live near a factory, mine, shipyard or other facility that might have released hazardous materials?

YES ______ NO_____ DON'T KNOW_____

IF YES:

	1st	2nd
12A. What type of facility was that?	a.	
12B. What hazardous materials were used there?	b.	
12C. Where was he/she living at the time:	c. City: State/Country	

13. Did anyone in Mr. Mrs. Miss _________'s family, or anyone he/she lived with, work in a trade where hazardous or dusty materials could have been brought home?

YES _____ NO____ DON'T KNOW _____

IF YES:

	1st	2nd
13A. Who was this person? (RELATIONSHIP TO SUBJECT)	a.	
13B. What was this person's trade or job?	b.	
13C. Whaty type of materials or substances did this person work with?	c.	
13D. When might Mr. Mrs. Miss ________ first have come in contact with this? (RECORD YEAR)	d.	

14. Did Mr. Mrs. Miss ______________ ever smoke any tobacco products on a regular basis?

YES _______ NO _______ DON'T KNOW___

IF YES:

14A. What kind of tobacco products did (he/she) smoke?

1. cigarettes only	4. cigarettes and pipes
2. cigars only	5. cigarettes and cigars
3. pipes only	6. pipes and cigars

14B. About how old was he/she when he/she started to smoke regularly? ____________________________

14C Altogether, about how many years did he/she smoke? ___________

14D During the time when he/she was smoking, about how many cigarettes,(cigars, pipefulls)did he/she moke per day, on the average? ____

15. This next set of questions deals with Mr. Mrs. Miss __________'s mother and father, or the people he/she lived with as a child. First of all, did Mr. Mrs. Miss __________ live with both of his/her natural parents as a child, or with step parents or other guardians ? (SPECIFY)

_________________ Male

_________________ Female

IF NO MALE GUARDIAN OR PARENT, SKIP TO 16

---

15. FATHER/MALE GUARDIAN:

15A. While Mr. Mrs. Miss ______________ lived with his/her parent(s)/ guardians, what was his/her ______________ 's major occupation?
(male guardian)

(RECORD) ____

____

15B. Do you know of any other jobs he held while Mr. Mrs. Miss ________ was living with him? (RECORD) ______________________________

____

IF APPROPRIATE, BASED ON SUBJECT'S AGE AND RESIDENCE HISTORY:

15C. Did Mr. Mrs. Miss ______________ live with his/her ______________ during World War II?
(male guardian)

YES ____ NO _____ DON'T KNOW ____

IF YES:

15D. Do you know what job his/her ______________ did during the war?
(male guardian)

(RECORD) ____

____

15E. Is Mr. Mrs. Miss ______________'s ______________ alive at present?
(male guardian)

YES _____ NO ____ DON'T KNOW ____

15F. IF NO:

Do you know what the cause of his death was?

(RECORD) ____

IF NO FEMALE GUARDIAN OR PARENT, SKIP TO 17

---

16. MOTHER/FEMALE GUARDIAN:

16A. While Mr. Mrs. Miss ________________ lived with his/her parent(s)/ guardian(s), what was his/her ____________________'s major occupation?
(female guardian's)

(RECORD) ____

____

16B. Do you know of any other jobs she held while Mr. Mrs. Miss ______________ was living with her? (RECORD) ______________________________________

____

____

IF APPROPRIATE, BASED ON SUBJECT'S AGE AND RESIDENCE HISTORY:

16C. Did Mr. Mrs. Miss ______________ live with his/her __________________ during World War II?
(female guardian)

YES ____ NO ___ DON'T KNOW ___

IF YES:

16D. Do you know what job his/her __________________ did during the war?
(female guardian)

(RECORD) ____

____

16E. Is Mr. Mrs. Miss ____________________ alive at present?
(female guardian)

YES ___ NO ___ DON'T KNOW ___

IF NO:

16F. Do you know what the cause of her death was?

(RECORD) ____

17. That's all of the questions that I have about Mr. Mrs. Miss ______________. But, before we finish, there are a few short questions I have to ask you about yourself. We need this brief information so that we can learn about the different kinds of people that are helping us with this survey.

18. First, what is your birth date? ______ DAY ______ MONTH ______ YEAR

19. What has been your major occupation? (RECORD) ______________________________

____

20. What was the highest grade in school you have completed? (CIRCLE CORRRECT NUMBER)

1	2	3	4	5	6	7	8	(GRADE SCHOOL)
9	10	11	12					(HIGH SCHOOL)
13	14	15	16					(COLLEGE OR POST HIGH SCHOOL TRAINING)
17								(SOME POST-COLLEGE EDUCATION)
18								(MASTER'S DEGREE)
19								(DOCTORATE DEGREE)

That finishes the questionnaire. Thank you very much for your cooperation.

TO BE COMPLETED BY INTERVIEWER IMMEDIATELY AFTER INTERVIEW:

21. RESPONDENT'S SEX WAS

1. MALE
2. FEMALE

22. RESPONDENT'S RACE WAS

1. WHITE
2. BLACK
3. CHICANO, HISPANIC
4. ORIENTAL
5. OTHER, SPECIFY

Additional information will be developed by requesting the interviewer to record several subjective observations such as -- respondent's interest, and the interviewer's participation of whether respondent seemed sure/unsure of answers.

4.6 INTERVIEWER TRAINING

Interviewers will undergo a thorough training program, conducted by the project staff, before conducting interviews in the field. The program will consist of several training sessions including a detailed exploration of the questionnaire instrument, the development of a professional attitude, and maintenance of impartiality.

The training program will conclude with the interviewers conducting simulated interviews on each other and the project staff. These mock interview sessions and the completed questionnaire forms will be checked by the project staff, and discussed with the interviewer providing feedback on their performance.

The goal of these sessions is to train interviewers to ask the questions and record the responses uniformly and without bias.

Interviewers will also be given an interviewer's manual for their reference, including a question by question description of the instrument, and covering various contingencies to handle situations that might be encountered in the field.

4.7 DATA MANAGEMENT

After the pretesting and interview training phase, we will design procedures for coding the responses in order to store the data in a computer file. A coding manual will be developed, detailing codes for specific responses, so that data will be recorded uniformly. We will specifically train persons to code the questionnaire responses in a standardized way.

The data will be keypunched from the coded questionnaires onto computer cards, and the data file will be stored on magnetic tape.

Data screening will be accomplished largely through packaged programs designed for this purpose in the BMDP series, to clean up the data set, and correct any items mispunched or miscoded.

The magnetic tape data file will be transmitted to EPA along with full documentation of the data file and questionnaire coding procedures.

4.8 QUALITY CONTROL

Information collected by the questionnaire can be assessed for reliability (consistency of respondent's answers) and validity (truthfulness of answers).

Reliability can be checked by repeating some of the questions to a ten-percent sample of respondents in a telephone call back. The call-back will also serve the function of interview quality control by confirming that interviews with respondents have in fact been conducted.

Validity can be assessed by comparing the respondent's answers to questions that are also included on the death certificate. Assuming that the death certificate information (e.g., birthdate, birthplace, date of death), filled out at the time of death is correct, questionnaire answers that disagree would signal that the respondent is not qualified to give accurate information.

The relationship of the respondent to the subject is also recorded. Different relatives or acquaintences may differ in their knowledge of the subject and their recall. For example, a spouse might give a more accurate lifetime residential history of the subject than the offspring might. On the other hand, a son might be better acquainted with the materials and processes used in his father's occupation than a wife. Examining the results by relationship of the respondent to the subject may indicate a recall bias.

We recommend a validity test be undertaken during the pretesting phase. We suggest testing the questionnaire by administering it to both a test "subject" (asking about him or herself), and a test next of kin "respondent" (asking about the subject). Taking the subject's history as truth, we can then examine the validity of the history elicited from the respondent.

Quality control during administration of the questionnaire will be accomplished by the following means. The questionnaire will be administered to the respondents by a specially trained interview staff. The interviewers will follow the format of the questionnaire strictly and impartially. Interviewers should also be blinded as to the case or control status of the subject. This will reduce the chance for observer bias, inherent in unblinded case/control studies (e.g., that by Zielhuis et al., 1975, of asbestos-rellated mesothelioma), where interviewers are tempted to search for exposures they feel might exist.

Interviewers will be given personal code numbers to be recorded on each questionnaire they administer. The results may then be compared from one interviewer to the next as a check of consistency between interviewers. A random 10-percent sample of respondents will be contacted later by telephone to confirm that the interview took place as reported.

REFERENCES

Arai, D.T., and H. Weill, "Clinical problems in asbestos related diseases." Asbestos-Related Disease, L. Preger (ed) Grune & Stratton, 1978.

Ayer, 1965, "A Comparison of Impinger and Membrane Filter Techniques for Evaluating Air Samples in Asbestos Plants," H. E. Ayer et al., Ann. N.Y. Acad., 132, Art. 1, 1965.

California, 1963. Industrial Hygiene Report Dated June 10, 1963, Anonymous.

California Department of Public Health, 1966, Occupational Health Study Pacific Asbestos Corporation Copperopolis, California, Principal Authors H.P. Blejer, A.E. Lowe, and F. Ottoboni, California Department of Public Health, Study No. 2931, October 1966.

California Department of Public Health, 1967, Industrial Health Study Wells Cargo, Inc., Pacific Asbestos Corporation Mine Copperopolis, California, A.E. Lowe, California Department of Public Health, Study 2963, August 1967.

Cannell, C.F., K.H. Marquis, and A. Laurent, "A Summary of studies of interviewing methodology," Vital and Health Statistics, Series 2. Data Evaluation and Methods Research, No. 69, U.S. Department of Health, Education and Welfare, 1977.

Cooper, 1979, "Chrysotile Asbestos in a California Recreational Area," W.C. Cooper, et al., Science, 209, 9, 685-688, November 1979.

Cooper, 1978, Asbestos in Domestic Water Supplies in Five California Counties, R. C. Cooper, et al., Progress Report, April 25, 1977 to June 30, 1978, U.S. Environmental Protection Agency, Contract R804366-02.

John, 1976, Experimental Determinations of the Number and Size of Asbestos Fibers in Ambient Air, W. John et al., California Department of Health, ARB 3-688, 1966.

McDonald, 1971, "Mortality in the Chrysotile Asbestos Mines and Mills of Quebec," J.C. McDonald et al., Arch. Envir. Hlth., 22, 677-686, 1971.

Millette, 1979, Exposure to Asbestos from Drinking Water in the United States, J.R. Millette, P.J. Clark, and M.F. Pansing, EPA-600/1-79-028.

Milne, J.E.H., "Thirty-two cases of mesothelioma in Victoria, Australia: A Retrospective Survey Related to Occupational Asbestos Exposure," Birt J. Ind. Med., 33:115-122, 1976.

Murchio, 1973, Asbestos Fibers in Ambient Air of California, J. C. Murchio, W.C. Cooper, and A. DeLeon, California Air Resources Board, March 1973.

Nicholson, 1971, *Measurement of Astestos in Ambient Air*. Final Report to the Environmental Protection Agency, W.J. Nicholson, Contract 70-92.

Nicholson, 1973, *The Copperopolis Study - Clinical and Environmental Evaluation*, W. Nicholson and I. Selikoff.

Orellana, M., and R. Armijo, "A Simple Device for Long-term Recollection in Chronic Disease Studies," *American Journal of Epidemiology*, 109(1): 77-78, 1978.

U. S. Bureau of Mines, 1972, *Health Study (Asbestos Dust)*, Pacific Asbestos Mill Pacific Asbestos Corporation Copperopolis Operation, W. Bank et al., U. Department of the Interior, Bureau of Mines, Health and Safety Technical Support, March 1972.

U.S. Department of Health, Education and Welfare,1978, *"Asbestos: An Information Resource,* DHEW Publication Number (NIH)78-1681, May, 1978.

U.S. Public Health Service, 1966. *An Environmental Survey of Asbestos Mining and Milling in California*, Principal Authorts, J.R. Lynch and D.L. Johnson, U.S. Department of Health, Education, and Welfare, Public Health Service, Division of Occupational Health, Report SR-17, December 1966.

Weslowski, 1975, "Asbestos Measured in the California Environment," In *Recent Advances in the Assessment of the Health Effects of Environmental Pollution*, Vol. III, Commission of the European Communities, 1975.

Zielhuis, R.L., J.P.J. Versteeg, and H.T. Planteijdt, "Pleural Mesothelioma and Exposure to Asbestos: A Retrospective Case-Control Study in the Netherlands." *Int. Arch. Occupat. Environ. Hlth*. 36:1-18, 1975.